

**“IMPACT OF BIOFERTILIZER USE ON CROP
PRODUCTIVITY IN AHMEDNAGAR DISTRICT.”**

By

ES42

Yashwant Chandrabhan Sale

(Reg. No.02097)

**A Thesis Submitted to the
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST. - AHMEDNAGAR,
MAHARASHTRA (INDIA)**

in partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS

**POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI – 413 722, DIST. AHMEDNAGAR,
MAHARASHTRA , INDIA.**

2004

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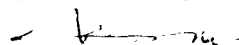
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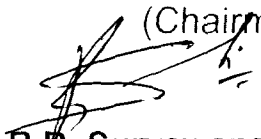
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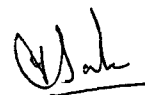
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or Institute for
a Degree or
Diploma.

Place : MPKV, Rahuri

Dated : 10 / 12 / 2004



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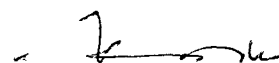
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This is to certify that the thesis entitled **“IMPACT OF BIOFERTILIZER USE ON CROP PRODUCTIVITY IN AHMEDNAGAR DISTRICT.”** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra state, India, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ECONOMICS**, embodies the results of a piece of *bona fide* research work carried out by **Mr.Yashwant Chandrabhan Sale**, under my guidance and supervision and no part of the thesis has been submitted for any other degree or diploma or published in any other form.

The assistance and help received during the course of this investigation and sources of literature referred to have been acknowledged.

Place : MPKV, Rahuri

Date : 10 /12 /2004



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Maharashtra, India.

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Place : MPKV, Rahuri
Date : 10 /12 / 2004


(**D. M. Sawant**)
Associate Dean

ACKNOWLEDGEMENTS

I wish to take this opportunity to express my deep and sincere feelings of gratitude to my Research Guide Dr. D. V. Kasar, Head, Department of Agricultural Economics, MPKV, Rahuri under whose lofty inspiration, constant supervision and unfailing interest this investigation was undertaken and completed. I am also indebted to him for his encouragement and scholastic guidance in selecting this topic and help in preparing the manuscript. He was a source of strength to me in carrying this work, for which I remember him forever.

I am grateful to Dr. R. R. Suryawanshi, Associate Professor of Agricultural Economics, Dr. P. V. Wani, Associate Professor of Plant Pathology and Microbiology. Dr. B. H. Khan, Assistant Professor of Statistics, MPKV, Rahuri, the members of my advisory committee, for their valuable guidance, helpful or comments and constructive suggestions in this investigation.

I wish to express my sincere thanks specially and honestly to Dr. Vasant G. Pokharkar and Prof. V. A. Shinde who have shown keen interest in the research work and constructive suggestions at various stages in this investigation.

I am indebted to Prof. K. R. Waykar, Dr. B. V. Pagire, Prof. B. K. Mali, Prof. P. N. Shendge, Prof. D. S. Hange, H. R. Shinde, B.

N. Pawar, S.D.Patole, G.G.Joshi, G.D.Gaikwad, Ravi
Bansode, Prashant Bhosale, Pradeep Ahire, K.M.Kamble and
V.C.Shinde for their valuable help and guidance.

*I am also highly indebted to my father late
Chandrabhan Baburao Sale whose memories inspired me for hard
work and honesty. It is with this sense of gratitude that this piece of
research work has been dedicated to him.*

*I will be failing in my duties, if I do not thank my wife
Mrs. Vijaya for her inspiration and constant assistance, Mother
Indubai, Brother Sanjay, Sister Meena and Sangita for their love
and uncountable support for elevating my educational status and
life career.*

Place : MPKV, Rahuri

Date : 10/12 / 2004



(Y. C. Sale)

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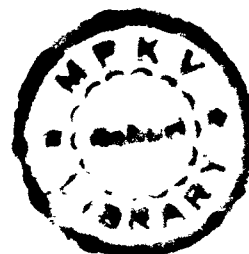
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ABSTRACT

“IMPACT OF BIOFERTILIZER USE ON CROP PRODUCTIVITY IN AHMEDNAGAR DISTRICT”

By

Yashwant Chandrabhan Sale

A candidate for the degree of

MASTER OF SCIENCE (AGRICULTURE)

in

Agricultural Economics

Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

2004

Research Guide	:	Dr. D. V. Kasar
Department	:	Agricultural Economics

The present study has been undertaken to examine the nature and extent of biofertilizer use, estimate the resource use levels, costs and returns and resource use productivities of major inputs in order to assess the impact of biofertilizer use on productivity of crops and also to identify the constraints in biofertilizer use at the farm level. The study is based upon the primary data collected from a sample of 120 farmers comprising 60

Abstract contd.....

each of biofertilizer users and 60 non-users drawn randomly from the five villages of Rahuri tahsil in Ahmednagar district. The data pertained to the reference year 2002-03. The data were subjected to both simple tabular method as well as regression analysis keeping in view the objectives of study. A Cobb-Douglas type of production function was used for estimating the resource use productivities of major inputs used in production of important crops on the farms of both biofertilizer users and non-users. This became useful not only to compare resource use productivities but also to compare overall production relations of these two categories for assessing the impact of biofertilizer use.

The size of family and its composition, level of literacy and capital assets owned by the sample farmers varied greatly among biofertilizer users and non-users. The earning family members were more in biofertilizer users than that of non-users. The proportion of illiterate persons was more in biofertilizer non-users than that of users. The average size of holding was a bit more in biofertilizer users, while cropping intensity was more in biofertilizer non-users. The proportion of irrigated area was more than 5.85 per cent in case of biofertilizer non-user farms than user farms. The proportionate share of foodgrains, vegetables and fruit

Abstract contd.....

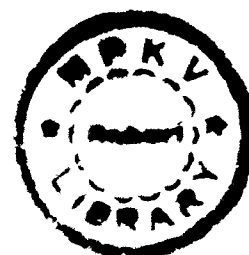
crops was more in biofertilizer users, while the share of oilseed crops and sugarcane was more in non-users.

The study revealed that the per hectare use of biofertilizer was more than recommendation in case of bajra, soybean, chilli and brinjal ,while it was less than recommendation in case of wheat, gram, onion, groundnut, tomato and sugarcane. An average per hectare productivity of crops was found to be increased due to use of biofertilizers. The per hectare use of manures was less than recommendation except gram, use of nitrogen was less than recommendation except tur, gram and groundnut. The per hectare use of phosphorus was more than recommendation in case of vegetable crops and use of potash was more than recommendation in case of tur, gram, groundnut and soybean. The per quintal cost of production of crops was less than those of non-used crops, while the B : C ratio was a bit higher in case of biofertilizer used crops. The coefficients of biofertilizer use observed to be highly significant in case of sugarcane, groundnut, gram and wheat. The constraints regarding the utilization of biofertilizers reported by the farmers were high cost of liquid biofertilizers, lack of availability of biofertilizers in time, lack of technical know-how, not showing instant response like chemical

Abstract contd.....

fertilizers and inadequate popularity in the area under study. The study finally suggested that the use of biofertilizers at the farm level was either more or less than their recommendation for individual crops. There is a need to guide the cultivators about the use of biofertilizers by the extension agencies in the rural area of the state. The constraints such as high cost of liquid biofertilizers, lack of availability of biofertilizers in time and lack of technical know-how about their use need to be suitably removed in order to popularize its use for agriculture production.

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Chapter Opener Page

INTRODUCTION

1 . INTRODUCTION

1.1 General

Green revolution commenced during mid *sixties* in the country enabled to boost farm productivity in view of improved technology backup consisting of high yielding fertilizer responsive varieties. India has already attained self-sufficiency in foodgrains production and has reached a production level of about 182.57 million tonnes during the year 2002-03 (Agricultural statistics, At a glance 2003).

Fertilizer is a key input in agriculture as it provides essential nutrients to the crops and maintains the fertility of land to obtain the maximum yield to fulfill the need of growing population. Realising the importance of fertilizers in the development of agriculture in the country, Union Government introduced 'Fertilizer Retention Price Cum Subsidy Scheme' in November 1977. Under this scheme, fertilizers were supplied at subsidized prices to the farmers throughout the country with a view to minimize the cost of cultivation.

In a bid to check fertilizer use imbalance, the Indian Farmers Fertilizer Co-operative Ltd (IFFCO) has decided to popularize a new concept viz., Integrated Plant Nutrient Management with an object to retain soil fertility for sustaining farm

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non-symbiotic bacteria such as *Azotobacter* which could fix atmospheric nitrogen. It was followed by a third group called *Blue Green Algae*. In 1970, a new group of bacteria called *Azospirillum* was identified. Vesicular-Arbuscular Micorrhiza (VAM) is the latest introduction in the list of biofertilizers which mobilizes phosphorus.

In India, systematic research on biofertilizers started with the first study of N. V. Joshi in 1920. This was followed by extensive research by Gangulee, Sarkaria and Madhok on the physiology of the nodule bacteria and its inoculation for increasing crop yields.

Some milestones in research, production and promotion of biofertilizers in India are listed as below.

Year	Events
1920	First study on <i>Rhizobium</i> by N. V. Joshi
1934	Earliest production of <i>Rhizobium</i> by M. R. Madhok
1956	First commercial production of Biofertilizers.
1957	Study on solubilization of phosphorus by Sen and Pal.
1964	Spurt in demand of Biofertilizer for soybean particularly in Madhya Pradesh
1977	Use of ISI mark for <i>Rhizobium</i>
1983	Setting of National Project on Development and Use of Biofertilizers by Ministry of Agriculture, Govt. of India.
1986	Setting of National faculty for BGA collection at IARI, New Delhi by the Dept. of Biotechnology, Govt. of India.
1990	Setting of National faculty for <i>Rhizobium</i> at the Division of Microbiology, IARI, New Delhi by Department of Biotechnology, Govt. of India.

1.3 Scope for Biofertilizer Use

Integration of Indian economy with global economy and signing of agreement of agriculture under World Trade Organization has presented enormous opportunities as well as challenges to agricultural sector to become cost effective, competitive and quality conscious in the international market. If we can ensure high quality of our farm produce without chemical residues and sell it at competitive rates then we can export to any place in the globalised market. For this, we have to reduce the cost of cultivation of different crops by utilizing the eco-friendly biofertilizers in the place of chemical fertilizers. It is necessary to avoid the utilization of high quantity of chemical fertilizers with an aim to have an ecological sustainable farm production, maintaining the soil fertility.

The alarming growth of population in geometric proportions in entire world motivates man to find ways and means of ameliorating food production. The frenzied use of chemical fertilizers drove agricultural production to new heights. With the over enthusiastic application of chemical fertilizers simply created a divide between man and nature, consequently the food we consumed became venomous. The air we breathed was contaminated. Biofertilizers thus took birth in research for resolving the problems that accumulated over the years. Now, it is possible to increase agricultural production without injuring the nature. Man

realized that health is wealth. Biofertilizers have now attained importance all over the globe.

With the introduction of high yielding crop varieties more and more chemical fertilizers are required to be used. Among these, nitrogenous fertilizers are required the most, since Indian soil is deficient in nitrogen. Though, environment has a greater proportion of nitrogen (79 per cent) but crops cannot use it unless converted into ammonia. Biofertilizers are such micro-organism that help for making the availability of nitrogen to the crop.

Biotech Consortium India Ltd. New Delhi estimated that the demand of biofertilizer for India had increased from 10.73 lakh tonnes from the year 1992-93 to 28.35 lakh tones in the year 2001-02. The production of biofertilizers in India was 13027.40 tonnes for the year 2000-01. It indicates that the scope for the use of biofertilizers is very wide.

1.4 Biofertilizer Units in Maharashtra

Biofertilizer production units are located as follows :

1. Agriculture Bacteriology section, College of Agriculture, Pune
2. Ajay Bio-tech (India) Ltd.,Khalad, Pune.
3. BAIF Laboratory Ltd.,Briahnagar, Wagholi, Pune.

4. Farm Organics India Pvt. Ltd., Khole Niwas, Gurudwara Road, Kopergaon, Dist. Ahmednagar.
5. Indian Organics Chemicals Ltd., Khopoli, Dist. Raigad.
6. RCF limited ,Main street sector-12, Hiranandani Garden, Powai, Mumbai.
7. K. Ferts Lab, Gurunanak Market, Nanded.
8. Kisan Agro Chemical, Bhatia complex, Near Gujrathi High School, Vazirabad, Nanded.
9. Kumar krishi Mitra Bio-products Pvt. Ltd., Ganeshwadi, Pune.
10. College of Agriculture, Marathwada Agricultural University, Parbhani.
11. RCF Ltd, Sion, Mumbai.
12. Regional Biofertilizer Development Centre, Civil lines, Nagpur.
13. Maharashtra Agro-industries Development Corporation Ltd., MIDC Industrial Estate, Chinchwad, Pune.
14. Green Fibldo Agrotech. Urmila Society, Dhankawadi, Pune.
15. Niku Bio-research Laboratory, Nanapeth, Pune.
16. Inora Division of know-how foundation, karve Road, Pune.
17. Bio-E. Technologies, Link Road, Sadar, Nagpur.
18. Biodynamic products, oriental apartment, Kothrud, Pune.

19. A. V. S. Agro products-Nimgaon-Jali, Tal. Sangamner, Dist. Ahmednagar.
20. Nooscute Lab (I) Pvt. Ltd.,Tiwari industries estate, Goregaon (E), Mumbai.
21. Bharat Laboratories and Technologies for Agriculture, Near Rajkamal Theatre, Dhule.
22. Nav Maharashtra Chakan Oil Mills Ltd.,Shaniwar Peth, Pune.
23. Nirantan Biotech, Vinayak Ginja Society, NIT College Road, Pune.
24. Nirmal Seeds Ltd. Bhadgaon Road, Tal. Pachora, Dist. Jalgaon.
25. Krishival Biofertilizers, MIDC, Islampur, Tal. Walwa, Dist. Sangli.
26. Maharashtra Bio-tech Industries, Kisan Kunj, Wanawadi, Pune.

1.5 The Problem

Biofertilizers are the new cost-effective renewable source of plant minerals to supplement chemical fertilizers. The cultivators are being attracted towards the use of biofertilizers as they have realized the utility of biofertilizers in boosting crop productivity through the crop experiments conducted on farms by extension agencies. The use of biofertilizers even then has not

spread widely for all crops. However, there is a lack of awareness among the farmers for use of biofertilizers for the crops like cereals, pulses, oilseeds, vegetables and sugarcane.

There is also a need to provide guidelines to farmers by extension agencies for proper utilization of biofertilizers for maximum crop productivity. It is a well established fact that due to mono-cropping, the fertility and the productivity of the soil deteriorates. At present, majority of farmers use inorganic fertilizers with organic fertilizers to meet total nutrient requirement in crop production. As a result of continuous use of inorganic fertilizers, alkalinity and salinity of soil have increased leading to reduction in the physical and biological fertility of the soil.

In dry land farming, average productivity of foodgrains is low and unstable due to inadequate and uncertain rainfall. Majority of the dry land farmers are economically poor to invest in costly chemical fertilizers and to bear risk of crop failures. Therefore, it is necessary to use low cost technology of biofertilizers to meet the gap between requirement and availability of nutrients.

There is a need for scientific assessment of impact of use of biofertilizers on crop productivity and returns on farms. Besides the constraints in the use of biofertilizers of the cultivators level need to be identified for extension of their use. It would be an interesting exercise to examine and compare the resource use

productivity of major inputs and production relations on the farms using biofertilizers with that of farms not using at all. The need is felt to know the nature and extent of use of biofertilizers on farmers fields just to visualize the gap and pattern of their use at the cultivators level. It is in this context, the present study viz., impact of biofertilizer use on crop productivity in Ahmednagar district is taken up with the following specific objectives.

1.6 Objectives of the Study

1. To examine the nature and extent of biofertilizer use on sample farms.
2. To assess the effects of bio-fertilizer use on productivity of crops.
3. To estimate the resource use levels, costs and returns of bio-fertilizer used and non-used crops.
4. To estimate the resource use productivities of major inputs of biofertilizer used and non-used crops.
5. To study the constraints in use of biofertilizers at the farm level.

1.7 Hypotheses of the Study

In the light of the foregoing theoretical propositions and the review of literature presented in the next chapter, the following hypotheses are proposed to be tested for fulfilling requirements of the objectives of the study

1. Farmers use the biofertilizer in the powder form.

2. The use of biofertilizers is below the recommended levels for major crops.
3. Biofertilizers are useful for increasing the crop productivity.
4. Inputs with biofertilizer use are more efficient.
5. The high cost of liquid biofertilizer, lack of availability in time, lack of technical know how about the use and inadequate popularity among the cultivators are the major constraints in the use of biofertilizers.

1.8 Scope and Utility of the Study

The demand for foodgrains is continuously increasing due to increase in world population in general and India in particular. The gap between the demand and availability of food grains has been reduced by bringing more land under intensive agriculture. In this context, the use of bio-fertilizers plays a vital role to bridge the gap between the demand and availability of food grains through a boost to productivity on one hand and by reducing the cost of production on the other. The findings of the present study would be useful for deciding the strategy of extension of biofertilizer use in agriculture under similar situations. The findings will be applicable to similar situations for framing suitable policies needed for balanced use of fertilizers.

The study would provide guidelines to farmers for proper utilization of biofertilizers for maximum yield with minimum cost of production.

Chapter Opener Page

*REVIEW OF
LITERATURE*

2. REVIEW OF LITERATURE

In any systematic research, the review of literature on relevant aspects under study forms an integral part of the research work. Such exercise would help in highlighting the methodology and results obtained by different research workers in similar fields and would serve as a guideline for the research to be carried out. Thus, it helps in proper understanding of the concepts, methodological and analytical issues relating to the problem under study.

The major theme of the present study is to examine the impact of biofertilizer use on crop productivity and farm returns. This chapter reviews the available literature on different methodological issues and empirical results arrived at by various research scholars from similar past studies. For the sake of convenience, the reviews so obtained have been grouped under the following major heads and briefly abstracted a below.

- 2.1 Nature and extent of use of biofertilizers.
- 2.2 Effects of biofertilizers on crop productivity.
- 2.3 Constraints in use of biofertilizers.

2.1 Nature and Extent of Use of Biofertilizers.

Rangaswami (1982) based on his work on research and development for BNF in India reported that interest of BNF research and development in India increased in recent years

because of the gap in the nitrogen fertilizer demand and supply. Currently the amount of Rs. 2 millions is spent annually in BNF research and Rs. 12 millions for development emphasis towards a better understanding of legume/rhizobium symbiosis. The greater attention had also been paid recently to use of *Azolla*, N_2 fixing BGA and associative symbiosis. It is hoped that saving of fertilizer use could be achieved.

Singh (1983) studied asymbiotic and symbiotic algae nitrogen fixation biofertilizer technology for rice. He reported that the nitrogen fixation in paddy by BGA and more recently by *Azolla* was established and found to be practicable in India. The paddy field experiment was most suited for their growth and nitrogen fixation. The comparative trials conducted at CRRI farm revealed that rice crop response to *Azolla* inoculation was better than BGA inoculation.

Bagal *et al.* (1984) studied the influence of combined effect of nitrogen, *Azotobacter* and *Blue green algae* on the yield of paddy. The fertilizer treatments in combination with algae were found significantly superior to other treatments at 50 kg N/ha. The blue green algae inoculation was found superior over remaining treatments. The data indicated that the use of blue green algae could reduce the nitrogen dose to the extent of 16 per cent.

Desale *et al.* (1984) studied on the response of sorghum to seed bacterization with nitrogen level. They reported

that 25.30 per cent as the recommended dose of nitrogen fertilizer could be saved with seed inoculation with *Azotobacter* in sorghum crop.

Thorat (1986) studied on effect of *Azotobacter* and *Azospirillum* alone and in combination under graded levels of nitrogen on growth and yield of ridge gourd. He reported that *Azotobacter* and *Azospirillum* increased nitrogen content of ridge gourd (2.37 %) over the uninoculated control (2.27 %) and also significant effect on root length, shoot length and dry weight of ridge gourd plant.

Madhavan (1987) studied 'Adoption of *Rhizobium* by dryland pulse growers'. He reported that for successful launching of biofertilizer programme, it is necessary to equip extension machinery at the root level with full technical backup of production and application technology.

Verma *et al.* (1991) conducted the study on development and use of biofertilizer in India. They observed that biofertilizers were cost effective as well as environment friendly. They had favourable influence on soil health. Biofertilizers were compatible with chemical fertilizers and agrochemicals like pesticides and herbicides without demanding extra or special care in their handling safe to crops and users both.

Biosyi (1994) studied on 'scope and limitations of biofertilizers use in Tamilnadu, Karnataka and Kerala states. He

reported that biofertilizer could be used as a blend with chemical fertilizers effectively provided drought tolerant and improvement in crop yield.

Palarpawar (1995) conducted study on 'Effect of *Rhizobium* and phosphotica on germination and growth of gram seedlings'. He concluded that *Rhizobium* and *PSB* enhance early germination of seed, obtaining maximum plant population in field and seed could sustain in waterlogged condition which avoided rotting.

Anonymous (1995) conducted a study on 'Utilization of *rhizobium* inoculation technique in advanced sown NH-44 hybrid cotton'. It has been found through lab to land programme that rainfed cotton farmers were often able to apply only 50 per cent N, 50 per cent P_2O_5 and 25 per cent K_2O . This represented that *Azotobacter* and *Azospirillum* could be best exploited for atmospheric nitrogen fixation, solubilization of fixed phosphorous.

Bhattacharya *et al.* (2000) based on their study viz., 'Liquid-biofertilizer –current knowledge and future prospect' concluded that liquid biofertilizer technology could be considered as a breakthrough in field of biofertilizer technology. Interest on biofertilizer technology was growing rapidly in many countries all over the world.

Mercy *et al.* (2000) studied adoption of biofertilizers technology. They reported that some strategies like organisation of

field demonstrations, group meetings, trainings and publicity should be adopted at field level for wider acceptance of biofertilizers.

Sudhakar *et al.* (2000) worked on effect of foliar application and reported that foliar application was more effective than field inoculation as the energy for efficient fixation of atmospheric nitrogen was provided by the photosynthesis present in the leaf leachates, hydrolysis of leaf polymers, lipids and metabolization of leaf waxes which were not available in the soil. Biofertilizer sprayed on foliage of plant could perform well even under adverse conditions like high temperature, humidity and low rainfall because these bacterial cells would get embedded in such a way that a micro-aerobic condition developed aided by the hairs on the surface.

Sule (2001) studied on average per hectare pattern and extent of biofertilizer use. He observed that use of biofertilizer in Bajra, soybean, pigeonpea, green gram and rabi jowar was 74.40 per cent, 86.00 per cent, 111.20 per cent, 45.20 per cent and 52.00 per cent, respectively which was more than recommended dose. In case of wheat, onion and sugarcane use of biofertilizer was less than recommended dose. He further reported that size of holding was an important factor influencing the use of biofertilizer.

Anonymous (2003) studied on adoption of biotechnology in Maharashtra. They observed that in small size category 62.80 per cent farmers in medium size category 74.07 per

cent farmers and 67.65 per cent of large farmers used biofertilizers. As regards region wise adoption, it was noted that 96.15 per cent, 93.55 per cent and 100 per cent of the farmers used biofertilizers in Western Maharashtra Marathwada and Vidarbha, respectively. The study further concluded that adoption of biofertilizers was more than other biotechnologies i. e. use of biopesticides, use of vermi compost and tissue culture.

Mishra *et al.* (2003) stated that *Azolla* has high nitrogen fixing ability, rapid growth, determined it as an excellent nitrogen biofertilizer for rice crop due to the fact that paddy field formed an ideal environment for its growth. *Azolla* contains 0.2-0.3 per cent nitrogen on fresh weight and 3-5 per cent nitrogen on dry weight basis. It had a potential of fixing more than 70 to 75 kg nitrogen ha^{-1} in a month to the rice crop.

Mahajan *et al.* (2003) studied importance of biofertilizers in sustainable agriculture. They stated that *Rhizobium* fixed nitrogen to be extent of 50-55 kg ha^{-1} for mung, 50-60 kg ha^{-1} for groundnut, 60-80 kg ha^{-1} for soybean, 80-80 kg/ha for cowpea, 90-100 kg ha^{-1} for lentil and 100-300 kg ha^{-1} for alfalfa. *Azotobacter* save about 15-20 kg N ha^{-1} in cereals and millets. Use of *Azotobacter* reduced 20 to 50 per cent inorganic fertilizer requirements. *BGA* excreted vitamin B-12, auxins and ascorbic acid which contribute to the growth of rice plants.

Singh *et al.* (2003) studied on improvement of soil health by *Blue Green Algae* and *Azolla* biofertilizer. They indicated that these *BGA* contribute 25 to 30 kg pure nitrogen per hectare per season to the rice crop and there was progressive increase in the grain yields. It improved the soil fertility and had a residual effect on the yield of succeeding crops. Besides this *Azolla* suppressed weed growth and reduced losses of applied chemical N fertilizer as well as methane from the flooded rice fields. The successful use of this biofertilizer in one million hectare rice area would result in a saving of more than 60 thousand tonnes of urea.

Chandel *et al.* (2003) studied the role of bio-fertilizers in crop production. They stated that a number of experiments conducted in the country indicated that the crop response to biofertilizers was more consistent in cereals and legume crops. Therefore, this should be formed important constituent of the integrated plant nutrient system. Use of biofertilizers would be helpful not only to sustain the soil fertility but also to keep soil environment to be pollution free.

To sum up, the above reviews clearly indicated that, saving of chemical fertilizers could be achieved by using biofertilizers. According to trials conducted at CRRI, the paddy was most suited for their growth and nitrogen fixation by *Azolla*. Biofertilizer were cost effective as well as environment friendly. Some strategies like organization of field demonstrations, group meetings, trainings and publicity should be adopted at field level for

wider acceptance of biofertilizers. If biofertilizers sprayed on foliage of plant, it could perform well even under adverse conditions. Besides, use of biofertilizer in bajra, soybean, pigeonpea, green gram and rabi jowar was more than recommended dose, while in case of wheat, onion and sugarcane, it was less than recommended dose.

2.2 Effects of Biofertilizer Use on Crop Productivity

Desale (1980) studied that effect of bacterization with *Azotobacter* and *Azospirillum* culture under various levels of nitrogen on growth and yield of sorghum and maize. He observed that the application of increased dose of nitrogen (0, 33, 66 and 100 kg N ha⁻¹) supplemented with *Azotobacter* and *Azospirillum* resulted in increased plant height, number of leaves, plant dry matter weight and grain yield of sorghum and maize.

Kundu *et al.* (1980) studied effect of *phosphobacteria* on yield and phosphate uptake of potato crop. They carried out field trials with *PSB* and reported that tuber yields became 10.36, 12.74, 13.54 and 13.99 t ha⁻¹ and P₂O₅ uptake of 4.43, 6.46, 5.92 and 6.29 kg ha⁻¹, respectively.

Musmade *et al.* (1980) conducted a study on effects of inoculation of *Azospirillum* in yield of onion. They reported that 17.68 per cent increase in onion bulb due to *Azospirillum* inoculation over the uninoculated control.

Konde *et al.* (1981) conducted a study on dry matter production of grain yield and nitrogen uptake in maize as influenced by N levels, *Azotobacter* and *Azospirillum* inoculants. They reported that maize seed bacterization with *Azotobacter* and *Azospirillum* resulted in 21 per cent increase in grain yield of maize under field conditions.

Bhargava (1981) studied the response of *Azotobacter* under varying levels of nitrogen in bajra under unirrigated conditions. Seed inoculation with *Azotobacter* had significantly increased the grain and straw yield. Increase in grain and straw yield due to seed inoculation with *Azotobacter* was 3.51 and 9.88 q/ha respectively.

Gupta *et al.* (1982) studied on *Rhizobium* interaction on chickpea. They reported the significant increase in grain yield (16.67 per cent) of chickpea due to *Rhizobium* inoculants over uninoculated control.

Jagtap *et al.* (1982) studied 'influence of *Azotobacter* inoculation on conjugation with FYM in economising use of fertilizer nitrogen to wheat. The study conducted for continuous three years and reported that 120 kg N/ha + 10 MT FYM /ha + *Azotobacter* inoculation had significantly increased the grain yield by 21.84 per cent over control.

Rai *et al.* (1982) studied Nitrogen fixation by *Azospirillum* on the yield and uptake of wheat crop. They reported

that N uptake and yield of wheat had increased by 36 per cent due to inoculation with *Azospirillum* over the uninoculated control.

Reynder *et al.* (1982) conducted a study on use of *Azospirillum* as biofertilizer in intensive wheat cropping. They reported the increase in the yield of wheat by 9.14 per cent and 14.82 per cent in winter wheat due to inoculation with S-631 and Br-14 strain of *Azotobacter* respectively over the uninoculated control.

Agnihotrudu *et al.* (1983) studied effects of *Azotobacter* on chillies with various doses of nitrogen addition in field. They reported that *Azotobacter* inoculation to chilli seeds with half of recommended nitrogen dose had given same growth and yield as that of recommended nitrogen dose alone.

Emmimath (1983) studied the influence of *Rhizobium* inoculants on yield and dry matter production of arhar and found higher number of nodules, more dry weight of plants and 24 to 32 per cent increase in grain yield over uninoculated control.

Palarpwar (1983) concluded that the grain yield of wheat increased by 16 to 33 per cent due to inoculation. Inoculation of seed with *Azotobacter* also improved the germination by 30 per cent.

Sonawane (1983) studied on the effect of different method of *Azotobacterization* under various levels of nitrogen on growth and yield of brinjal (cv. Manjari gota). He observed that fruit

yield of brinjal was increased by 7 per cent due to Azotobacterization conjugation with increased levels of nitrogen.

Arunachalam *et al.* (1984) studied 'effect of bio-fertilizer application on the yield of sesamum'. They observed that yield of sesamum increased due to inoculation of *Azotobacter* and *Azospirillum*. There is a good possibility of reducing 50 per cent of fertilizer nitrogen by inoculation of bio-fertilizers without adversely affecting the yield.

Bhuiya *et al.* (1984) studied the effect of 0-60 kg N/ha and or 10 kg *blue green algae* inoculation per hectare on yield of rice in silty loam soil over 25 kg P and 20 kg K/ha which were applied to all treatments as a basal dressing. The combination of 40 kg N and 10 kg *blue green algae* per ha gave the highest grain yield (5.82 t/ha) which was 44 per cent higher than the untreated control yield of 4.02 t/ha.

Subbiah *et al.* (1984) studied effect of *Azotobacter* and *Azospirillum* on the growth and yield of sesamum. They observed that seed inoculation with *Azotobacter* and *Azospirillum* under graded levels of nitrogen significantly increased the plant height, number of branches, number of capsules per plant and seed yield in sesamum.

Osman *et al.* (1984) compared the growth and yield of rice grown in soil with or without 90 kg P and 30 kg K/ha with 0-112.5 kg N/ha and 6.25 tonne fresh *Azolla*/ha. The fertilizers

were applied as a basal dose while *Azolla* was applied 15 days after transplanting into plots flooded to 7.5 cm depth and incorporated into the soil after 1 month. *Azolla* increased the total N content of rice soils in all treatments when measured 10 days after incorporation. Application of P and K and increasing rates of N increased grain yield as compared to that of untreated control.

Kolhe (1985) studied effects of *Azotobacter* and *Azospirillum* alone and in combination under graded levels of nitrogen on growth, yield and quality of cabbage. He reported that *Azotobacter* and *Azospirillum* inoculations with graded level of nitrogen increased the root length, shoot length, number of leaves, dry weight of cabbage plants and yield. The treatment with *Azotobacter* + *Azospirillum* recorded the highest N uptake of $0.215 \text{ g plant}^{-1}$ whereas the uninoculated control had the N uptake of only $0.152 \text{ g plant}^{-1}$.

Kumar *et al.* (1986) conducted a study on the effects of *Azotobacter* culture and phosphorus levels on grain yield and test weight of sorghum (Cv. CSH-5). They noted that the seed inoculation with *Azotobacter* culture or no inoculation and 0, 20, 40 or 60 kg $\text{P}_2\text{O}_5/\text{ha}$ on sorghum inoculation increased grain yield by 20.8 per cent and test yield by 0-15 per cent as compared to control. Both grain yield and test weight of inoculated or non-inoculated plants increased with P rate of 0, 20, 40 and 60 kg P_2O_5 treatment, respectively. Grain yield of uninoculated sorghum was

2.3, 2.8, 3.3 and 4.1 t/ha and for inoculated sorghum 2.9, 3.3, 3.9 and 5.0 t/ha.

Shrivastava *et al.* (1986) conducted field experiment at the Ranchi Agriculture College Farm during kharif 1979-80 and 80-81 and results revealed that 100 kg P_2O_5 /ha application marked by increased in the grain yield of pigeonpea. *Rhizobium* along or in combination with nitrogen significantly increased the grain yield.

Parvathan *et al.* (1989) studied on effect of *Azospirillum* on growth and nutrient uptake of pusa sawani bhendi. They reported that there was an increase of 14 per cent yield of bhendi (Cv. *Pusa savani*) due to *Azospirillum* inoculation over uninoculated control.

Singh *et al.* (1989) studied the effects of *blue green algae* in rice fields. They showed that the field experiments conducted in India have reported about 24 per cent increase in yield over control which corresponds to 950 kg grain/ha. The experiment at CRRI indicated that *blue green algae* increased grain yield by 6 to 35 per cent.

Jadhav *et al.* (1990) conducted a study on response of rainfall pearl millet to biofertilizer. They reported that seed inoculation with *Azotobacter* to pearl millet increased the grain yield by 21.6 per cent as compared to uninoculated control.

Kulkarni *et al.* (1990) studied effect of *Azotobacter* and *Azospirillum* with nitrogen on yield of Aster. They reported that

Azotobacter + *Azospirillum* alongwith different nitrogen levels resulted in increase in shoot and root length, spread of plant, dry weight of plant, fruit yield and N uptake over uninoculated control.

Kumarswamy *et al.* (1990) had studied 'effects of *Azotobacter* inoculation on tomato'. They reported that *Azotobacter* + 30 kg N/ha recorded the higher yield of tomato (42.09 t/ha) as compared to 60 kg N/ha (41.52 t/ha).

Mazzitelli *et al.* (1990) studied effects of biofertilizer on propogation of grape and they reported that the use of biofertilizer enhanced the growth of grapevine.

Wani *et al.* (1990) conducted field experiments and showed that out of 1095 experiments, 890 experiments showed an increase in yield of cereals and vegetables due to inoculation with *Azotobacter*.

Dighe (1991) studied effect of *Azotobacter* and *Azospirillum* inoculation under graded levels of nitrogen on growth and yield of tomato. He reported that the highest tomato yield could be obtained with *Azotobacter* + *Azospirillum* inoculation along with full dose of nitrogen.

Shinde *et al.* (1992) studied on effect of *Azospirillum* inoculation on the yield of sugarcane crop. They reported that *Azospirillum* inoculation along with application of 300 kg N/ha to adsali sugarcane crop increased the cane yield by 8.61 per cent over uninoculated control in medium black soil.

Wani *et al.* (1992) studied on effect of *Azospirillum* inoculation on yield and N-content of pearl millet under different levels of nitrogen. They reported significant increase in number of tillers.

Kalaghatagi *et al.* (1996) conducted study for two consecutive years in shallow black soil under dry land conditions of seed treatment with *Azospirillum* and *phosphobacteria* in pearl millet. They observed that grain yield of pearl millet increased by 33 per cent with combination of biofertilizers and 50 per cent recommended dose of nitrogen and phosphorus (40 kg N + 20 kg P₂O₅/ha).

Tavarej (1996) studied the effect of phosphorous solubility biofertilizer (PSB) with phosphatic fertilizers in grapevine and reported increase in the available phosphorus in soil and significant improvement in vine height, internode length, stem girth, number of leaves, leaf area and N, P uptake by vines.

Ganguly *et al.* (1997) studied the effect of inoculation of *Azospirillum* in combination with *Bacillus megatherium* in Jute-cowpea-wheat cropping system. It was clearly seen that there was simultaneous increase in fibre yield of jute, green and dry matter of cowpea and grain and straw yield of wheat.

Sule (2001) studied 'effects of biofertilizer use on crop production'. He observed that productivity of bajra, soybean, pigeonpea, green gram, wheat increased by 15.07 per cent, 9.66



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per cent, 12.78 per cent, 8.11 per cent and 6.36 per cent percentage, respectively due to use of biofertilizer.

Giri *et al.* (2003) studied on Integrated Nutrient Management in oilseeds for a balance. They stated that biofertilizers had to play an important role in INM. By improving the nutrients supply with help of *Rhizobium* groundnut and soybean fixed atmospheric nitrogen about 112 to 152 kg/ha and 49 to 130 kg/ha, respectively and increased yield of summer groundnut by 15-30 per cent and in kharif groundnut by 13-53 per cent with *rhizboun* culture.

Rahane *et al.* (2003) studied 'effects of biofertilizers on productivity of kharif crops'. They concluded that the per hectare productivity of kharif crops showed an increase from 8 to 17 per cent while that of rabi crops increased from 6 to 23 per cent due to use of biofertilizers.

Kanaiya *et al.* (2003) studied biofertilizers for sustainable vegetable production. They conducted two year trials on peas and reported that *Rhizobium* proved a superiority over nitrogen application in pea. Combined application of *rhizobium* with phosphorous and potassium fertilizer increased yield by 122.70 per cent as compared to nothing applied with *Rhizobium*. They had also conducted trials on chilli plants. It is found that *Azotobacter* or *Azospirillum* saved 50 per cent of nitrogenous fertilizer in this crop.

It also recorded more plant height, number of fruit and fruit yield as compared to non- used crop.

To sum up the whole, it appears from the above reviews that, after use of *Rhizobium* in Chickpea, *Azotobacter* and *Azospirillum* in Maize, *Azotobacter* in Wheat, *Azotobacter* in Brinjal Blue Green Algae in Rice and *Azotobacter* in Pearlmillet productivity had increased by 16.67 per cent, 21.00 per cent, 21.84 per cent, 7.00 per cent, 44.00 per cent and 21.60 per cent, respectively.

2.3 Constraints in Use of Biofertilizers

It looks that the studies on constraint in the use of biofertilizers at the cultivators level are inadequate. However, an attempt will be made in the present study to examine in detail the constrains which inhibit the use of biofertilizers at the cultivators level.

Few studies referred in this regard are briefly abstracted as below.

Wakade *et al.* (1989) observed that there were constraints like non- availability of the *rhizobium* culture and non availability of subsidies in the use of biofertilizers on farmers field.

Anonymous (2003) studied the constraints in use of biofertilizer in Maharashtra. It was reported that 48.04 per cent farmers had constraints of unavailability of biofertilizers in time,

55.56 per cent farmers had lack of technical know-how in the use of biofertilizers, 63.73 per cent farmers had confusion for use of biofertilizers regarding its impact on productivity and 41.50 per cent of the sample farmers was completely in use of biofertilizers.

To sum up, above reviews clearly indicated that unavailability of biofertilizers in time was common constraint in the use of biofertilizers.

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METHODOLOGY

3 . METHODOLOGY

3.1 General

The present chapter is devoted to discuss the methodology adopted to arrive at specific findings. The study of any research problem needs to be conducted on scientific lines by adopting appropriate methodology in order to accomplish the specific objectives of the study. The details of the methodological aspects of the present investigation with regard to the selection of the study area, selection of sample, collection of data and method of analysis etc. are explained in brief as under.

3.2 Location of the Study

The present study viz. impact of biofertilizer use on crop productivity in Ahmednagar district has been taken up in Ahmednagar district of Western Maharashtra. The study was taken up in Rahuri tahsil of Ahmednagar district and the villages selected have been presented in Map of Rahuri tahsil in Fig. 1

3.3 Selection of Villages

As stated above, the present study was confined to Rahuri tahsil of Ahmednagar district in which the University Head Quarter of MPKV is situated. As the villages around the University campus, Rahuri are in touch with the ATIC for knowing recent

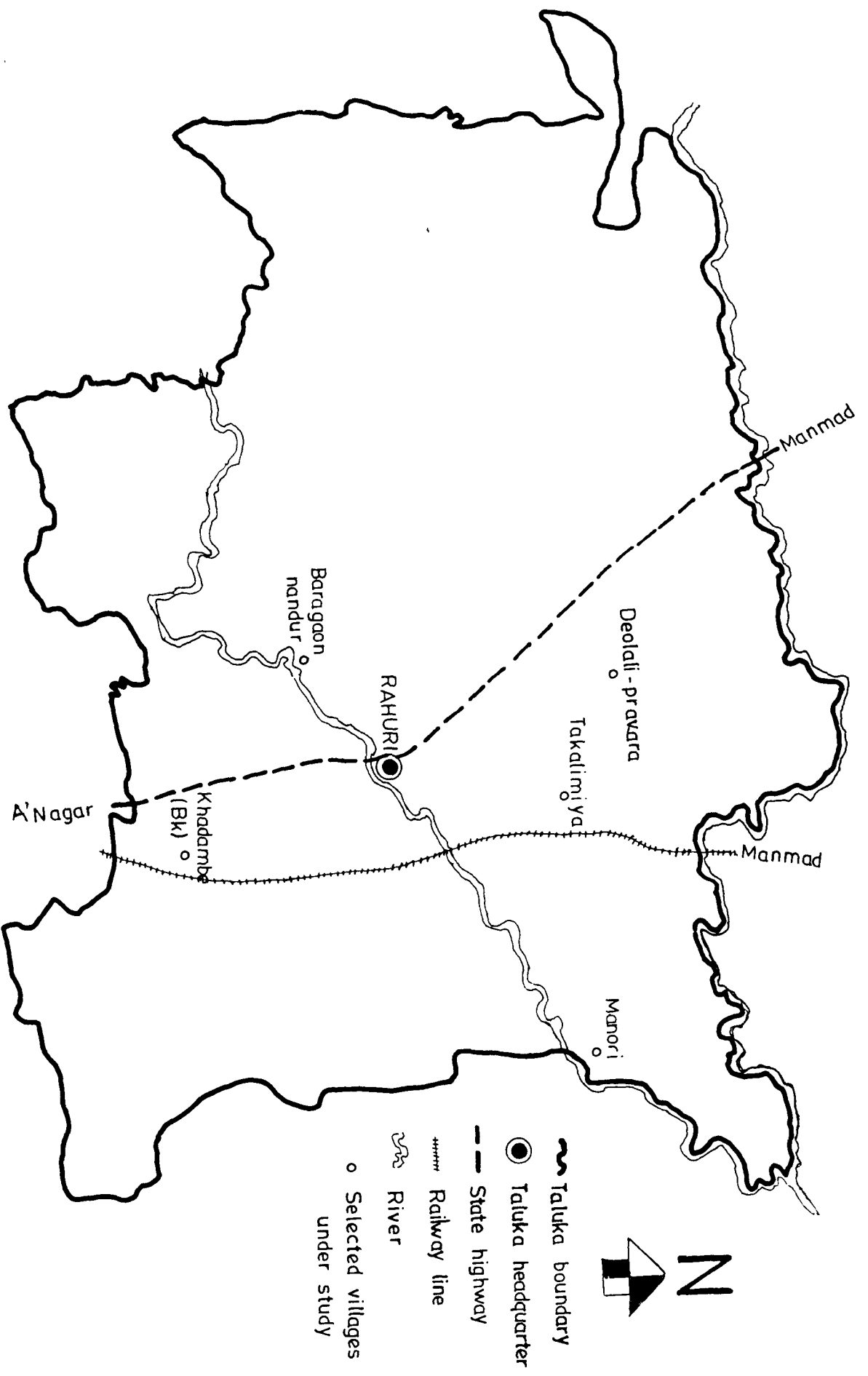
developments in the use of improved farm technologies. The users of biofertilizers are maximum in the tahsil of Rahuri. The list of villages where farmers are using biofertilizers was obtained not only from ATIC but also from taluka Panchayat Samati and Agro-Service Centres, Rahuri. The eighteen villages so identified were arranged in descending order of number of farmers using biofertilizers and the top five villages where the number of biofertilizer users was more were selected for the present study.

The villages selected from Rahuri tahsil are as under :

1. Baragaon Nandur
2. Takalimiya
3. Deolali Pravara
4. Khadambe (Bk.)
5. Manori

3.4 Selection of Sample Farms

The list of bio-fertilizer users and non-users for each of the selected villages was prepared on the basis of information obtained from ATIC, MPKV, Rahuri, Taluka Panchayat Samiti and also from the office of village Patwari. The biofertilizer users and non-users in a selected villages were arranged in ascending order of their operational holdings and 12 farmers each for users and non- users category were drawn through systematic random sample technique. Thus, the total sample for the study consists of 120 farmers comprising 60 bio-fertilizer users and 60 non-biofertilizer users spread over the five villages of Rahuri tahsil of



Map showing the selected villages in Rahuri tahsil, Dist. Ahmednagar.

Ahmednagar district. The distribution of sample biofertilizer users and non-users according to selected villages in Rahuri tahsil is indicated in Table 3.1

Table 3.1 Distribution of sample biofertilizer users and non-users according to selected village.

Sr. No.	Village	Biofertilizer users	Biofertilizer non-users	Total
1.	Baragaon Nandur	12	12	24
2.	Takalimiya	12	12	24
3.	Deolali Pravara	12	12	24
4.	Khadambe (Bk.)	12	12	24
5.	Manori	12	12	24
	Total	60	60	120

3.5 Method of Data Collection

The data on relevant aspects of the study keeping in view the objectives under study were collected from the sample of biofertilizer users and non-users for the year 2002-2003 by survey method with the help of a specially designed schedule for the purpose. The schedule designed included following points for collection of data.

1. Name of the Farmer.
2. Information about family members.

3. Information about land.
4. Cropping patterns.
5. Information on capital assets.
6. Utilization of biofertilizers for crop production.
7. Cost of Cultivation.
8. Constrains in the utilization of biofertilizers by the sample farms.

A copy of the schedule is also given in Appendix-I.

3.6 Analysis of Data

3.6.1 Tabular method

The simple tabular method of analysis is used for studying the nature and extent of use of biofertilizers, effect of biofertilizer use on crop productivity and constraints in the use of biofertilizers by sample farms. The effects of biofertilizers on crop productivity were examined by comparing productivity of selected crops on farms of users and non users. The simple tools such as averages, percentages and proportions were used to highlight the results of the study.

3.6.2 Cost concepts and evaluation of items of cost

The cost of cultivation of the major crops on bio-fertilizer user and non-user farms was estimated by applying

standard cost concepts which are normally usually used in farm cost studies. This analysis helped not only to estimate the cost of cultivation of crops of different levels but also as measures of farm income and the B : C ratios for major crops grown by the sample farms. This became useful to compare the cost and return structure of crops grown by biofertilizer users and non-users and accordingly to assess the impact of biofertilizer use on farm returns.

The specification of the cost concepts and returns used is as follows.

I. Cost A

It includes the items of expenditure such as :

1. Wages of hired human labour
2. Charges of owned and hired bullock labour
3. Cost of seed (Farm produced and purchased)
4. Cost of manures and fertilizers
5. Cost of machine labour used
6. Irrigation charges
7. Value of insecticides and incidental charges
8. Interest on working capital
9. Land revenue and other cesses
10. Depreciation on implements and machinery, maintenance charges of implements and machinery.

II. Cost B

It includes the Cost A plus rental value of land plus interest on fixed capital.

III. Cost C

It includes the Cost B plus the wages of family human labour.

IV. B : C Ratio

This is calculated by dividing the value of gross returns by cost 'C'

$$\text{B : C Ratios} = \frac{\text{Gross returns}}{\text{Cost 'C'}}$$

V. Measures of farm income

a) Farm Business Income

It is calculated by deducting the cost 'A' from the value of gross returns.

$$\text{Farm Business Income} = \text{Gross returns} - \text{Cost 'A'}$$

b) Farm Labour Income

It is calculated by deducting the cost 'B' from the value of gross returns.

$$\text{Farm labour Income} = \text{Gross returns} - \text{Cost 'B'}$$

c) Farm Net Income

It is obtained by deducting the cost 'C' from the value of gross returns.

$$\text{Farm Net Income} = \text{Gross returns} - \text{Cost 'C'}$$

3.6.3 Production function analysis

One of the objectives under study is to estimate and compare the resource productivity of major inputs used for growing important crops by the biofertilizer user and non-user farms. In order to attain this, Cobb-Douglas type of production function is used for estimating the resource use productivities of major inputs in five important crops viz., Wheat, Gram, Groundnut, Soybean and Sugarcane grown on the farms of biofertilizer users and non-users separately. The form of the production function used is as under

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} \dots X_4^{b_4} e^u$$

Where,

- Y = Yield in quintals per hectare
- X_1 = Total human labour in man days per hectare
- X_2 = Total bullock labour in pair days per hectare
- X_3 = Use of manures in quintals per hectare
- X_4 = Use of bio-fertilizers in grams/ha

X_5 = Use of nitrogen in kilograms per hectare

X_6 = Use of phosphorus in kilograms per hectare

X_7 = Use of potash in kilograms per hectare

X_8 = Other working capital in rupees per hectare

a = Intercept

b_1 to b_n = Production elasticities

u = Error term

In all thus, 10 production functions for the crops mentioned above have been estimated. The significance of the coefficient of each of the variables from the estimated equations was tested with the help of 't' statistic and the goodness of fit was judged on the basis of analysis of variance.

3.6.4 Specification of input variables

A great deal of caution needs to be taken up in selection of input variables in production function analysis for studying the resource use productivities. A brief description of inputs used as explanatory variables in the present study is given as below.

Human labour (X_1) :

In the present study, the human labour (Male + Female) used for land preparation, from sowing to harvesting operations has been considered in mandays and used as an explanatory

variable. One manday consists of eight hours of work performed by labour. The female labour considered equal to 0.75 man equivalent days.

Bullock labour (X_2) :

Bullock labour used for different farm operations has been measured in pair days. One pair day refers to eight hours of work done by one pair of bullocks.

Manures (X_3) :

The farm yard manure in quintals is taken as an explanatory variable.

Nitrogen (X_4) :

The nitrogen use measured in kilograms per hectare has been used as an explanatory variable.

Phosphorus (X_5) :

The Phosphorus use measured in kilograms per hectare has been used as a separate independent variable in the present study.

Potash (X_6) :

This variable is also taken separately in kilograms per hectare.

Other Working Capital (X_7) :

This variable included the expenditure on inputs such as seed, irrigation, plant protection, incidental charges and repairs of implements and machinery utilized for crop production. It is measured in rupees per hectare.

Biofertilizer (x_8) :

The biofertilizers viz., Rhizobium, Azotobacter, Azospirillum, and PSB used in grams per hectare are taken as an explanatory variable.

3.6.5 Statistical test for comparing production function relationship

In order to know whether the biofertilizer users and non-users belong to different production relations, the chow's test of equality has been applied (Gujarati, 1978). The test involved the following steps.

Step - I

Combine all the N_1 and N_2 observations of two samples and run the single pooled regression. From regression, obtain the residual sum of squares (RSS) say S_1 with $df = N_1 + N_2 - K$ where K is the number of parameters estimated.

Step - II

Run the two individual regressions (1) and (2) and obtain their RSS, say S_2 and S_3 with $df = N_1 - K$ and $N_2 - K$ respectively. Add these two SS say $S_4 = S_2 + S_3$ with $df = N_1 + N_2 - 2K$.

Step - III : obtain $S_5 = S_1 - S_4$

Step - IV : Apply the 'F' test as follows :

$$F = \frac{S_5 / K}{S_4 (N_1 + N_2 - 2 K)} \text{ with df} = (K, N_1 + N_2 - 2 K)$$

If computed 'F' exceeds the critical 'F' the hypothesis that the two regressions having the same production relations can be rejected.

Chapter Opener Page

*SOCIO-ECONOMIC
INFORMATION OF THE
SELECTED FARMERS
UNDERSTUDY*

SOCIO-ECONOMIC INFORMATION OF THE SELECTED FARMERS UNDER STUDY

This chapter is devoted to explain the socio-economic indicators of the sample farm families under study. This will enable to understand not only the socio-economic background of the sample households but also to understand the results of the present study for the year 2002-03. It is proposed to deal with the following points :

- 4.1 Size and composition of sample farm families
- 4.2 Earners in the farm families
- 4.3 Educational status of the sample farm families
- 4.4 Capital investment on sample farms
- 4.5 Land use pattern of the sample farms
- 4.6 Cropping pattern of the sample farms

4.1 Size and Composition of Sample Farm Families

The size and composition of the family could be considered as important factors affecting family consumption needs and they also indicate the available family labour force to work on farms. The selected 120 farm families for the present study are from five villages of Rahuri tahasil in Ahmednagar district of Western Maharashtra. The information on family size and its composition in respect of sample households is presented in Table 4.1

Table 4.1 Average size and composition of sample farm families for the year 2002-03

(Number)

Family members	Biofertilizer users	Biofertilizer non-users	Overall
Male	1.67 (39.02)	1.68 (40.19)	1.68 (39.62)
Female	1.31 (30.61)	1.45 (34.69)	1.38 (32.55)
Children	1.30 (30.37)	1.05 (25.12)	1.18 (27.83)
Total	4.28 (100.00)	4.18 (100.00)	4.24 (100.00)

(Figures in parentheses indicate percentages to the average size of family)

At the overall level, the average size of family was 4.24, the proportion of male, female and children was 39.62, 32.55 and 27.83 per cent respectively.

It is noted that the family size was a bit larger (4.28) in case of biofertilizer users than biofertilizer non-users (4.18). The proportion of male and female was larger in the case of biofertilizer non-users and the proportion of children was larger in case of biofertilizer users.

4.2 Earners in the Farm Families

The farming was the main source of earning of the selected families. Some farmers had secondary source of earning like service, business etc. The information relating to average earners in the sample farm families is given in Table 4.2

Table 4.2 Average number of earners on the sample farm families for the year 2002-03.

Earners	(Number)		
	Biofertilizer users	Biofertilizer non-users	Overall
Male	1.55 (58.49)	1.61 (55.51)	1.58 (57.04)
Female	0.95 (35.85)	1.03 (35.52)	0.99 (35.74)
Children	0.15 (5.66)	0.26 (8.97)	0.20 (7.22)
Total	2.65 (100.00)	2.90 (100.00)	2.77 (100.00)

(Figures in the parentheses indicate percentages to the total earners)

At the overall level, of the total earners, the proportion of males, females and children was 57.04, 35.74 and 7.22 per cent, respectively. In case of biofertilizer users, the proportion of male, female and children earners was 58.49, 35.85 and 5.66 per cent, respectively. In case of biofertilizer non-users, the proportion of male, female and children earners was 55.51, 35.52 and 8.97 per cent, respectively. However, it must be said that the proportion of

earners in the average size of family of biofertilizer users and non-users was 61.91 and 69.37 per cent, respectively.

4.3 Educational Status of the Sample Farm Families

Educational status of the family members is another important factor influencing the skill, ability to use resources and adoption of new technology. Table 4.3 presents the data on educational status of the sample farm families.

At the overall level, the proportion of illiterate persons was 9.43 per cent in the family. However, it was 5.85 and 13.40 per cent in the case of biofertilizer users and non-users, respectively. The proportion of members having education upto graduate level was 16.74 per cent in the family, at over all level.

The percentage of the persons educated upto XIIth standard was 13.68 per cent. The percentage of illiterates was more in case of biofertilizer non-users than users. The proportion of literates upto primary education more (31.30 per cent) in biofertilizer users) than that of non-users (28.95 per cent).

4.4 Capital Investment on Sample Farms

Capital investment is one of the indicators of increasing productivity of crops as well as improving economy of the farmers. Residence, cattle byre, irrigation structure, bullock drawn implements, hand tools and machinery are the important farm assets. These items of the capital investment were studied. The information on per farm capital investment for the year 2002-03 is presented in Table 4.4.

Table 4.3 Per farm educational status in the sample farm families during 2002-03

(Number)

Education	Biofertilizer users	Biofertilizer non-users	Overall
Upto 5 th	1.34 (31.30)	1.21 (28.95)	1.28 (30.19)
Upto 7 th	0.61 (14.25)	0.56 (13.39)	0.59 (13.92)
Upto 10 th	0.70 (16.35)	0.66 (15.79)	0.68 (16.04)
Upto 12 th	0.54 (12.62)	0.62 (14.83)	0.58 (13.68)
Graduate	0.84 (19.63)	0.57 (13.64)	0.71 (16.74)
Illiterate	0.25 (5.85)	0.56 (13.40)	0.40 (9.43)
Total	4.28 (100.00)	4.18 (100.00)	4.24 (100.00)

(Figures in parentheses indicate percentages to the average size of family).

It may be observed from Table 4.4 that the per farm value of capital assets was Rs. 2,66,172.54 and Rs. 1,92,228.97 in case of biofertilizer users and non-users respectively. The total capital investment at overall level worked out Rs. 2,29,200.75. It is also noted that the value of capital assets in case of biofertilizer users was more by 38.46 per cent than the non-users.

Table 4.4 Per farm value of capital assets of the sample farms during 2002-03

							(Rs)
Sr. No	Particulars	No.	Biofertilizer users	No.	Biofertilizer non-users	No.	Overall
1	Residence	1.01	146800.00 (55.15)	1.01	100433.33 (52.24)	1.01	123616.67 (53.94)
2	Cattle byre	1	21216.90 (7.98)	0.65	11688.33 (6.08)	0.82	16452.61 (7.18)
3	Well	1.33	43733.33 (16.44)	1.10	31150.00 (16.20)	1.21	37441.66 (16.34)
4	Electric motor	1.33	5500.00 (2.06)	1.10	2996.66 (1.55)	1.21	4248.34 (1.85)
5	Pipeline	0.23	11833.33 (4.45)	0.18	12050.00 (6.26)	0.20	11941.66 (5.22)
6	Drip / sprinkler	0.55	6983.33 (2.62)	0.18	3633.33 (1.89)	0.36	5308.33 (2.32)
	Irrigation structure		68049.99 (25.55)		49829.99 (25.91)		58939.99 (25.72)
7	Iron plough	0.28	1111.66 (0.41)	0.20	713.33 (0.37)	0.24	912.50 (0.39)
8	Seeddrill	0.18	458.33 (0.17)	0.16	495.00 (0.25)	0.17	476.66 (0.21)
9	Tractor	0.21	27416.66 (10.33)	0.20	28050.00 (14.59)	0.20	27733.33 (12.09)
10	Duster	0.13	120.00 (0.05)	0.16	143.33 (0.07)	0.14	131.66 (0.06)
11	Sprayer	0.76	521.00 (0.19)	0.50	341.66 (0.17)	0.63	431.33 (0.18)
12	Hand tools & machinery	13.68	478.00 (0.18)	11.90	534.00 (0.27)	12.79	506.00 (0.22)
13	Total		266172.54 (100.00)		192228.97 (100.00)		229200.75 (100.00)

(Figures in parentheses indicate percentages to the total assets)

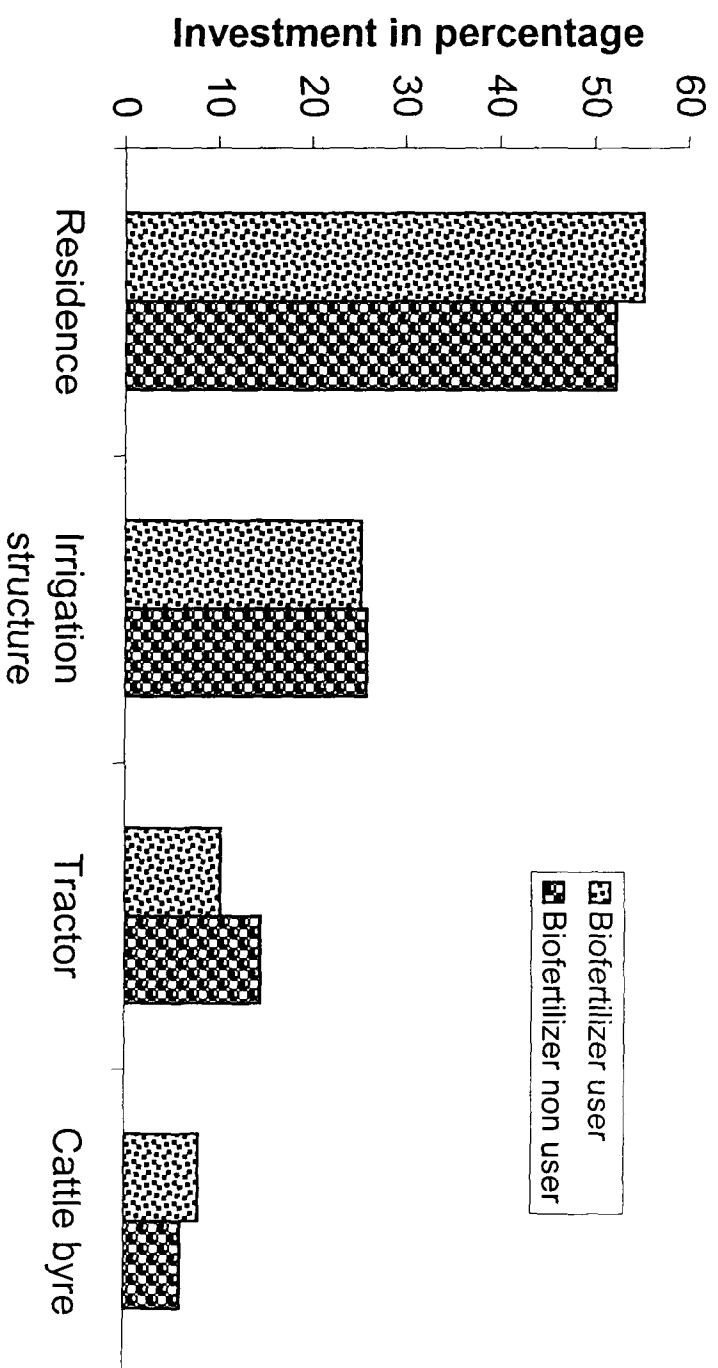


Fig. 2 : Average per farm investment on capital assest by biofertilizer users and non-users

At the overall level, the proportionate share of residence in the total capital investment was maximum (53.94 per cent) which was followed by irrigation structure (25.72 per cent), tractor (12.09 per cent) and cattle byre (7.18 per cent).

The proportionate share of residence and cattle byre in the total value of capital assets was maximum in case of biofertilizer users and the proportionate share of irrigation structure was maximum in case of biofertilizer non-users.

Average per farm investment on capital assets by biofertilizer users and non-users is graphically shown by way of a bar diagram in Fig. 2

4.5 Land Use Pattern of the Sample Farms

The details of the average size of holding and land utilization pattern of the sample farms for the year 2002-2003 are given in Table 4.5.

It could be revealed from the table that, at the overall level, the average size of holding was 2.10 hectares. The proportion of operational holding to the average size of holding, at the overall level was 97.61 per cent. The proportion of area under permanent fallow in biofertilizer users and non-users was about 1.29 and 3.21 per cent, respectively.

Table 4.5 Per farm land use pattern of sample farm families during 2002-2003.

(ha.)

Sr. No	Particulars	Biofertilizer users	Biofertilizer non-users	Overall
1	Total holding	2.33 (100.00)	1.87 (100.00)	2.10 (100.00)
2	Permanent fallow	0.03 (1.29)	0.06 (3.21)	0.05 (2.39)
3	Operational holding	2.30 (98.71)	1.81 (96.79)	2.05 (97.61)
4	Current fallow	0.06 (2.58)	0.10 (5.35)	0.08 (3.81)
5	Net cropped area	2.24 (96.13)	1.71 (91.44)	1.97 (93.80)
	a) Dry area	1.18 (50.64)	0.75 (40.10)	0.96 (45.71)
	b) Irrigated area	1.06 (45.49)	0.96 (51.34)	1.01 (48.09)
6	Double cropping	0.40 (17.16)	0.88 (47.05)	0.64 (30.47)
7	Gross cropped area	2.64	2.59	2.61
8	Cropping intensity (%)	117.85	151.46	132.49

(Figures in parentheses indicate percentages to the gross cropped area)

Importantly, the proportion of irrigated area in case of users was 1.06 ha, which accounted for 45.49 per cent of average size of holding, similarly in case of non-users, it was 0.96 ha, which accounted for 51.34 per cent of average size of holding. It may also be seen that the proportion of irrigated area was more than 5.85 per cent in case of biofertilizer non-user farms than user farms.

The net cropped area and the gross cropped area was higher in biofertilizer users as compared to non-users. It is interesting to note that the proportion of double cropped area was more (47.05 per cent) in biofertilizer non-users as compared to users which was only 17.16 per cent. The cropping intensity was also higher in biofertilizer non-users (151.46 per cent) than the biofertilizer users (117.85 per cent).

4.6 Cropping Pattern of the Sample Farms

The cropping pattern is dependent on several factors such as soil type, climate, resources available with the farmers, commodity requirements of the farm families, decision making ability of the cultivator under the situation of changing prices, price structure and relative price of output of different crops. The average cropping pattern of the sample farms for the year 2002-03 is presented in Table 4.6.

At the overall level, the average per farm total cropped area was 2.61 hectares. It was observed that foodgrain crops occupied a dominant position in the cropping pattern contributing 38.70 per cent to the gross cropped area. It was followed by

sugarcane (29.50 per cent), oilseed crops (15.70 per cent), vegetable crops (9.58 per cent) and fruit crops (6.52 per cent).

The proportionate area under foodgrain crops, vegetables and fruit crops was maximum in biofertilizer users as compared to non- users. The proportionate area of sugarcane and oilseed crops was maximum in biofertilizer non-users as compared to users. The proportionate share of different crops in the gross cropped area of biofertilizer users and non-user farms is graphically shown by bar graph in Fig. 3.

To sum up, it can be said that the average size of the sample farm families was 4.24 persons at the overall level. The proportion of male and female was a bit more in case of biofertilizer non-users and the proportion of children was more in case of biofertilizer users. The proportion of male and female earners was more in biofertilizer users than the non-users. The percentage of illiteracy was more in case of biofertilizer non-users than the users. The proportionate share of residence and cattle byre in the total value of capital assets was maximum in case of biofertilizer users. The percentage of cropping intensity was more in case of biofertilizer non-users (151.46 per cent) where it was less in case of biofertilizer users (117.85 per cent). The proportionate area of foodgrains, vegetables and fruit crops was maximum in biofertilizer user farms while that of sugarcane and oilseed crops was maximum on the farms of biofertilizer non-users.

Table 4.6 Per farm cropping pattern of sample farms during 2002-2003.

(Area in hectares)				
Sr. No.	Particulars	Biofertilizer users	Biofertilizer non-users	Overall
	Cereals			
1	Bajra	0.18 (6.82)	0.15 (5.80)	0.16 (6.13)
2	Jowar	0.09 (3.40)	0.12 (4.63)	0.11 (4.22)
3	Wheat	0.44 (16.67)	0.46 (17.76)	0.45 (17.24)
4	Other	0.02 (0.76)	0.03 (1.15)	0.02 (0.76)
	Total cereals	0.73 (27.65)	0.76 (29.34)	0.74 (28.35)
	Pulses			
5	Tur	0.10 (3.78)	0.08 (3.09)	0.09 (3.45)
6	Gram	0.20 (7.58)	0.16 (6.18)	0.18 (6.30)
	Total pulses	0.30 (11.36)	0.24 (9.27)	0.27 (10.35)
	Total foodgrains	1.03 (39.01)	1.00 (38.61)	1.01 (38.70)
	Oilseeds			
7	Groundnut	0.22 (8.33)	0.19 (7.34)	0.21 (8.04)
8	Soybean	0.17 (6.44)	0.22 (8.49)	0.20 (7.66)
	Total oilseeds	0.39 (14.77)	0.41 (15.83)	0.41 (15.70)
9	Sugarcane	0.74 (28.04)	0.80 (30.88)	0.77 (29.50)
	Vegetables			
10	Onion	0.12 (4.54)	0.10 (3.86)	0.11 (4.21)
11	Chilli	0.04 (1.52)	0.02 (0.78)	0.03 (1.14)
12	Brinjal	0.05 (1.89)	0.04 (1.54)	0.04 (1.53)
13	Tomato	0.03 (1.14)	0.03 (1.16)	0.03 (1.14)
14	Others	0.05 (1.89)	0.04 (1.54)	0.04 (1.53)
	Total vegetables	0.29 (10.98)	0.23 (8.88)	0.25 (9.58)
15	Fruit crops	0.19 (7.20)	0.15 (5.80)	0.17 (6.52)
	Gross cropped area	2.64 (100.00)	2.59 (100.00)	2.61 (100.00)

(Figures in the parentheses indicate percentages to the total)



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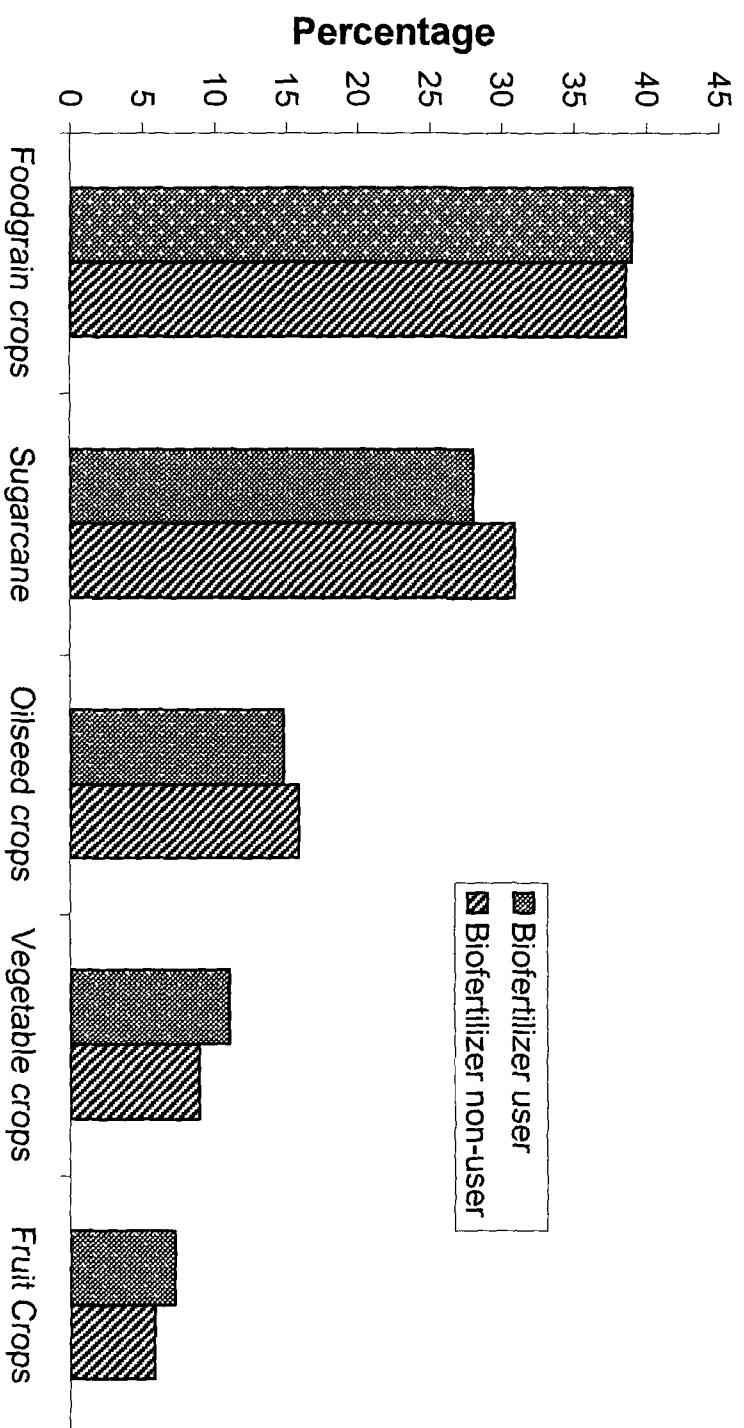


Fig. 3 : The proportionate share of different crops on sample farms of biofertilizer user and non-user farms.

Chapter Opener Page

*RESULTS AND
DISCUSSION*

5 . RESULTS AND DISCUSSION

This chapter is devoted to explain the results of data analysis in accordance with the objectives under study. It is therefore planned to present the results on the aspects such as nature and extent of biofertilizer use for different crops and its effects on crop productivity, resource use levels, costs and returns, resource use productivities of major inputs used in production of important crops on the farmers of both biofertilizer users and non-users besides the constraints in biofertilizer use in this chapter.

5.1 Nature and Extent of Biofertilizer Use on Sample Farms in *Kharif* Season

The crop wise information on the per hectare actual use and recommended dose of biofertilizer and extent of gap between recommended dose and actual use of biofertilizers in *kharif* season for the year 2002-03 is presented in Table 5.1. The extent of use of biofertilizers by sample farms is graphically presented by way of a bar graph in Fig .4.

5.1.1. Bajra

The biofertilizers like *Azotobacter*, *Azospirillum* and *phosphate solubilizing bacteria (PSB)* were observed to be used in powder form for bajra cultivation. The per hectare actual use of *Azotobacter*, *Azospirillum* and *phosphate solubilizing bacteria* was to the extent of 300 , 330 and 150 gms which was 20 per cent, 32

per cent and 50 per cent more than the recommended dose for bajra crop, respectively. It is also noted that the use of *Azotobacter* was made by 13.33 per cent of sample biofertilizer users while that in the case of *Azospirillum* and phosphate solubilizing bacteria (PSB) was negligible. This has indicated that the extent of adoption of biofertilizer use for bajra crop was very limited. However, the extent of use was more than the recommended dose.

5.1.2. Tur (Pigeon pea)

The biofertilizer like *Rhizobium* was used for tur in powder form. The use of this biofertilizer was 338 gms per hectare which was more than the recommended level by 35.20 per cent. The biofertilizer viz; *Chargex* was also used in liquid form for tur. The use of *Chargex* was 125 ml/ ha which was less than the recommended level by 16.66 per cent. It was also noted that the use of *Rhizobium* and *Chargex* was made by 16.66 and 1.65 per cent of sample biofertilizer users , respectively.

5.1.3. Soybean

The biofertilizers like *Rhizobium* and phosphate solubilizing bacteria were observed to be used in powder form for soybean cultivation in area under study. The use of *Rhizobium* and phosphate solubilizing bacteria was 511 gms and 1500 gms per hectare which was more than the recommended dose by 2.20 per



महाराष्ट्र शासनाचे कृषि विद्यापीठ, राहुरी (महाराष्ट्र)

रायझोबियम जीवाणू संवर्धन

M.P.K.V.'S RHIZOBIUM INOCULANT

Nitrogen Fixing Bacteria for Leguminous Crops.

DIRECTIONS FOR USE :

- The contents of packet are sufficient for 10 to 15 kg seeds.
- Use only for the leguminous crops mentioned before the expiry date.
- Mix the inoculant uniformly with the seeds gently with the minimum amount of water taking care to avoid damage to seed coat. Dry the inoculated seeds under shade over clean paper or gunny bag and sow immediately.
- This is not a chemical fertilizer and hence do not mix inoculated seeds or Rhizobium inoculant with chemical fertilizers.
- If the seed is to be treated with pesticides, first follow the pesticide treatments and finally treat seeds with Rhizobium inoculant.
- STORE IN COOL PLACE AWAY FROM DIRECT SUN AND HEAT. USE THIS PACKET FOR

मसुरीसाठी वजन : २५० ग्रॅम

माध्यम : निम्बार्ड

किंमत रु. : १०.०० (दहा)

होमवर्गीय टिटल पिकासाठी व
विचरीकरण जीवाणू
वापरार्थीची सूचना :

- पॅकिटशील जीवाणू संदर्भ १० ते १५ किलो विधान्यास पुरेसे आहे.
- सुविचाराने वाचून घ्यावे व शेतीसाठी किती विधान्याची प्रतीक कितीही टिपणे घ्यावे.
- पॅकिटशील जीवाणू संदर्भ पुरेसा पाहताच विधान्यास विधान्यास हाव्यावरून असा घट्टीने लावावे की सर्व विधान्यास हाव्यावरून असा घट्टीने लावावे व त्याचा पृष्ठभाग हाव्या होवार् नये. जीवाणू लावलेले विधान्यास हाव्यावर किती कितीही हाव्यावर हाव्यावर असा घट्टीने लावावे.
- जीवाणू संदर्भ हे राखण्यासाठी घ्यावे व त्यास हाव्यावर जीवाणू संदर्भ किती जीवाणू संदर्भ लावलेले विधान्यास हाव्यावर असा घट्टीने लावावे.
- हुराची सावध किती कितीही विधान्यास हाव्यावरून असा घट्टीने लावावे असा घट्टीने लावावे व शेतीसाठी कितीही विधान्यास हाव्यावरून असा घट्टीने लावावे.
- जीवाणू संदर्भाला पॅकिट हाव्यावरून असा घट्टीने लावावे व उभ्या हाव्यावरून असा घट्टीने लावावे.

या विधान्यासाठी वाचू

उपयुक्त विधान्या

अतिशय किती

उत्पादक : कृषि अनुजीवशास्त्रज्ञ, कृषि महाविद्यालय, पुणे ४११ ००५.

(महाराष्ट्र) पोस्ट : ५४३००३, विमान : ४३२ / ४३०

Mfgs. : Agricultural Bacteriologist, College of Agriculture, Pune.

The plate of Rhizobium Inoculant

Table 5.1 Nature and extent of biofertilizer use for important kharif crops grown (2002-03)

Sr. No	Name of crop	Name of biofertilizer	Form of use	No. of users	% of users	Actual dose gms/ha	Recom mended dose gms/ha	Actual gap in use (gms)	Per cent excess(+) or deficit(-)
1	Bajra	Azotobacter	Powder	8	13.33	300	250	+50	20.00
		Azospirillum	Powder	1	1.66	330	250	+80	32.00
		P. S. B.	Powder	1	1.66	150	100	+50	50.00
2	Tur	Rhizobium	Powder	10	16.66	338	250	+88	35.20
		Chargex	Liquid	1	1.65	125 ml	150 ml	-25	-16.66
3	Soybean	Rhizobium	Powder	16	26.65	511	500	+11	2.20
		P. S. B.	Powder	1	1.66	1500	1000	+500	50.00
4	Ground-nut	Rhizobium	Powder	14	23.34	930	1500	-570	-38.00
		Chargex	Liquid	7	11.65	130 ml	150 ml	-20	-13.33
		P. S. B.	Powder	2	3.34	5000	3000	+2000	66.67
5	Onion	Azospirillum	Powder	1	1.65	525	1250	-725	-58.00

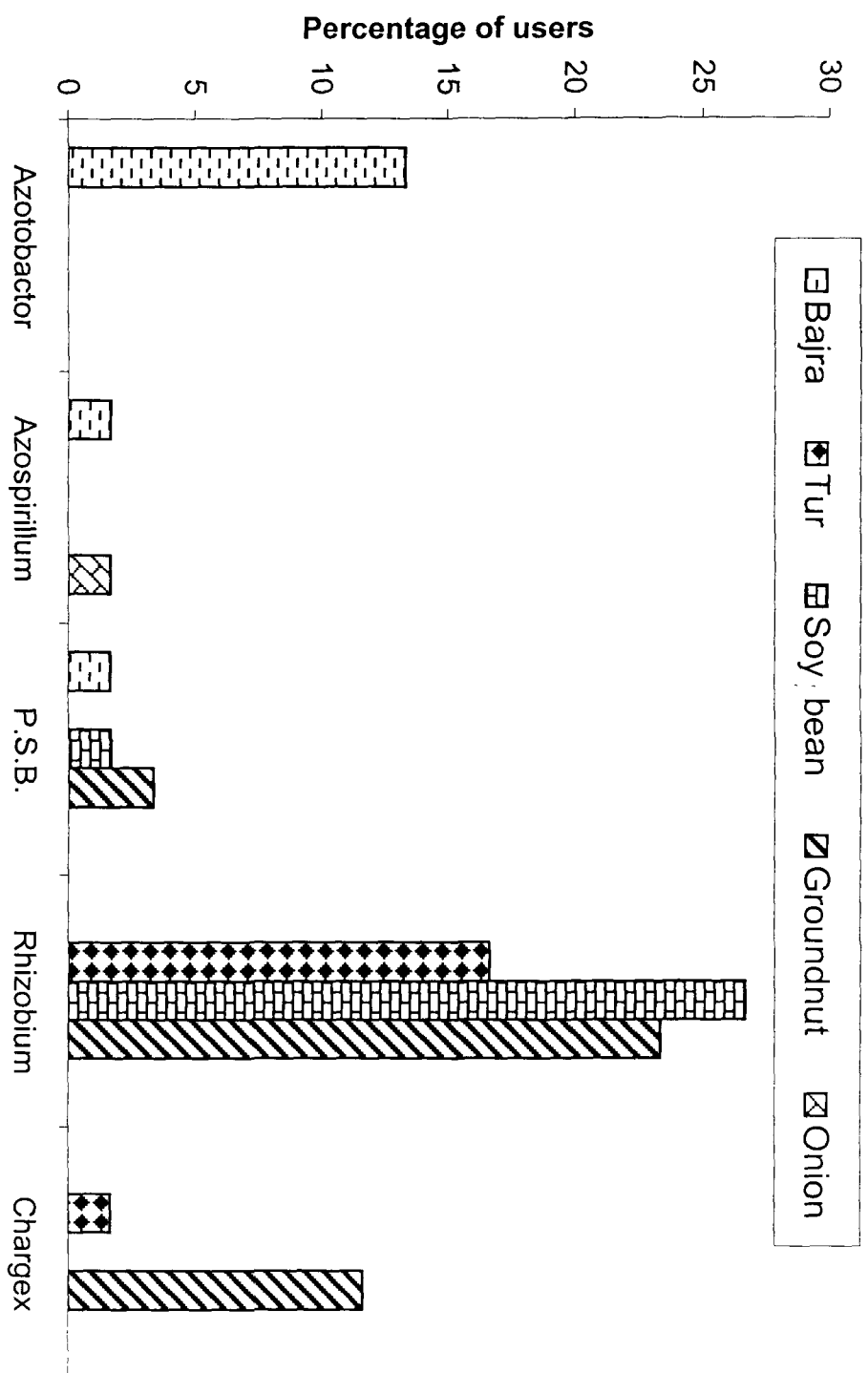


Fig. 4: Extent of use of biofertilizers by sample farms in kharif season 2002-2003

cent and 50.00 per cent, respectively. It was observed that 26.65 per cent of sample cultivators used *Rhizobium* and 1.66 per cent used *P.S.B.* for soybean.

5.1.4. Groundnut

The biofertilizers like *Rhizobium* and phosphate solubilizing bacteria were used in powder form and *Chargex* was also used in liquid form. The use of *Rhizobium* and *Chargex* was less than recommended dose by 38.00 per cent and 13.33 per cent, respectively and use of phosphate solubilizing bacteria was more than the recommended level by 66.67 per cent. It was observed that 11.65 per cent of sample farms had used liquid biofertilizer i.e. *Chargex* and 23.34 per cent and 3.34 per cent of the sample farms had used *Rhizobium* and *P.S.B.*, respectively.

5.1.5. Kharif Onion

The *Azospirillum* biofertilizer was used in powder form for kharif onion cultivation. The application of biofertilizer was 525 gms per hectare which was less than the recommended level by 58.00 per cent. In case of onion only 1.65 per cent of cultivators had used *Azospirillum* biofertilizer on their farms.

To sum up, It can be said that in kharif season, the sample farmers used *Rhizobium* for production of soybean (26.65 per cent) followed by groundnut (23.34 per cent) and tur (16.66 per cent). The per hectare use of biofertilizers was more than the recommended level in the case of bajra and soybean. The per



The plate of Azotobacter

hectare use of liquid biofertilizers was a bit low than the recommended level, especially in the case of tur and groundnut. It is also noted that, by and large, the use of biofertilizers may be in powder or liquid form, has not been popularized since the per cent of users in sample farms was very low in the area under study.

5.2 Nature and Extent of Biofertilizer Use on Sample Farms in Rabi Season

The crop wise information on the per hectare actual use, recommended dose and extent of gap between recommended and actual use of biofertilizer in rabi season for the year 2002-03 has been presented in Table 5.2. The extent of use of biofertilizers by the sample farms in rabi season is graphically shown by way of bar diagram in fig. 5.

5.2.1. Wheat

Both *Azotobacter* and phosphate solubilizing bacteria were used for wheat in powder form. In case of *Azotobacter*, the biofertilizer use was 909 gms per hectare which was less than recommendation by 39.40 per cent. The use of phosphate solubilizing bacteria was equal to the recommended dose. About 59 per cent and 5 per cent of sample farmers had used *Azotobacter* and P.S.B, respectively, for wheat crop on their farms.



महाराष्ट्र कृषि विद्यापीठ, राहुरी (महाराष्ट्र)

अझोटोबॅक्टेर जीवाणू संवर्धन

M.P.K.V.'S. AZOTOBACTER INOCULANT

Nitrogen Fixing Bacteria for
All Non-Leguminous Crops.

सर्व एकदल व तुणधान्य पिकांसाठी
मत्र निधीकरण जीवाणू

DIRECTIONS FOR USE:

- The contents of packet are sufficient for 10 to 15 kg. seeds.
- Use for the Non-leguminous crops, use before the expiry date.
- Mix the inoculants uniformly with the seeds gently with the minimum amount of water, taking care to avoid damage to seed coat. Dry the inoculated seeds under shade over clean paper or gunny bag and sow immediately.
- For transplanted crops : Mix the inoculant in bucket of water, stir the mixture vigorously. Dip the roots of seedlings in this mixture before transplanting. Transplant as usual.
- This is not a chemical fertilizer and hence do not mix inoculated seeds or Azotobacter inoculated with chemical fertilizers.
- If the seed is to be treated with pesticides, first follow the pesticide treatment and finally treat seeds with Azotobacter inoculant.
- STORE IN COOL PLACE AWAY FROM DIRECT SUN AND HEAT. USE THIS PACKET FOR:
Jowar, Bajra, Wheat, Maize, Paddy, Cotton, Sugarcane, Vegetables, Fruit Trees and Ornamental Plants

- आपणालाईही सूचना
- पॅकिटातील जीवाणू संवर्धन १० ते १५ किंलो विधान्यास पुरेसे आहे.
- पॅकिटर मधून केलेल्या सर्व एकदल व तुणधान्य पिकांसाठी अंतिम दिनांकानुसार वापरावे.
- पॅकिटातील जीवाणू संवर्धन पुरेसा पाण्यामध्ये विरलून विधान्याला हलक्यापणे असा घालावे. लांबी वी सर्व विधान्य बांधकाम प्रणालीत रोवत व लांब्या तुणधान्य बांधकाम (पिका, मारी, जीवाणू लावलेले विधान्य लावलीत यापुढे बांधकाम किंवा विधान्यावर घुसकावे अंतिम लावणीवर पोहोचली करावी.
- रोपणी लावली केल्यावर एक बाजली पाण्यामध्ये जीवाणू संवर्धन विरलून मिश्रण तयार करावे. रोपणी मध्ये या मिश्रणात घुसवून लावली करा.
- जीवाणू संवर्धन हे रासायनिक घट्ट मारी अंतिम मधून जीवाणू संवर्धन किंवा जीवाणू संवर्धन लावलेले विधान्य रासायनिक घट्टात घुसवू नये.
- दुष्पटोपाय किंवा विधान्यामध्ये विधान्यास लावण्याची आवश्यकता असेल असा प्रक्रिया पूर्व केल्यावर रोपणी रोपणीवर लावली.
- जीवाणू संवर्धन पॅकिट लावलीत पॅकिटावर घुसकावे व उण्यात घुसवून दूर घुसकावे किंवाही करावे.
- या पिकांसाठी वापरा : ज्वारी, बाजरी, मूग, मसूर, भात, जमरु, उख, बटाटा, भाजीपाला, फळवृक्ष अंतिम रोपणी करावे

पॅकिटाची वजन : १५० ग्रॅम

किंमत : रु. १०.०० (एक) माध्यम : मिश्रित अंतिम दिनांक :

उत्पादक : कृषि अनुसंधान साधक, कृषि महाविद्यालय, पुणे - ४११ ००५

(महाराष्ट्र) फोन : ५५३७०३३ विस्तार : २३२ / २२८

Mfgs. : Agricultural Bacteriologist, College of Agriculture,
Pune - 411 005, (M.S.) Ph. : 5537033 Extn. : 232 / 228

The plate of Azotobacter (M.P.K.V) Inoculant

Table 5.2 Nature and extent of biofertilizer use on sample farms in rabi season (2002-03)

S. N	Name of crop	Name of biofertilizer	Form of use	No. of users	% of users	Actual dose (gms/ha)	Recommended dose (gms/ha)	Actual gap in use (gms)	% excess or deficit
1	Wheat	Azotobacter	Powder	35	58.33	909	1500	-591	-39.40
		P. S. B.	Powder	3	4.99	2500	2500	-	-
2	Gram	<i>Rhizobium</i>	Powder	13	21.66	542	1000	-458	-45.80
		Agrostrong	Liquid	3	4.99	365ml	500 ml	-135	-27.00
3	Onion	Azospirillum	Powder	4	6.67	1083	1250	-167	-13.36
		Azotobacter	Powder	4	6.67	690	1250	-290	-44.80
		Altrabio	Liquid	2	3.33	250 ml	500 ml	-250	-50.00
4	Tomato	Azospirillum	Powder	1	1.67	1250	1250	-	-
		Agrostrong	Liquid	2	3.33	330 ml	500 ml	-170	-34.00
5	Chilli	Chargex	Liquid	3	4.99	250 ml	150 ml	+100 ml	66.67

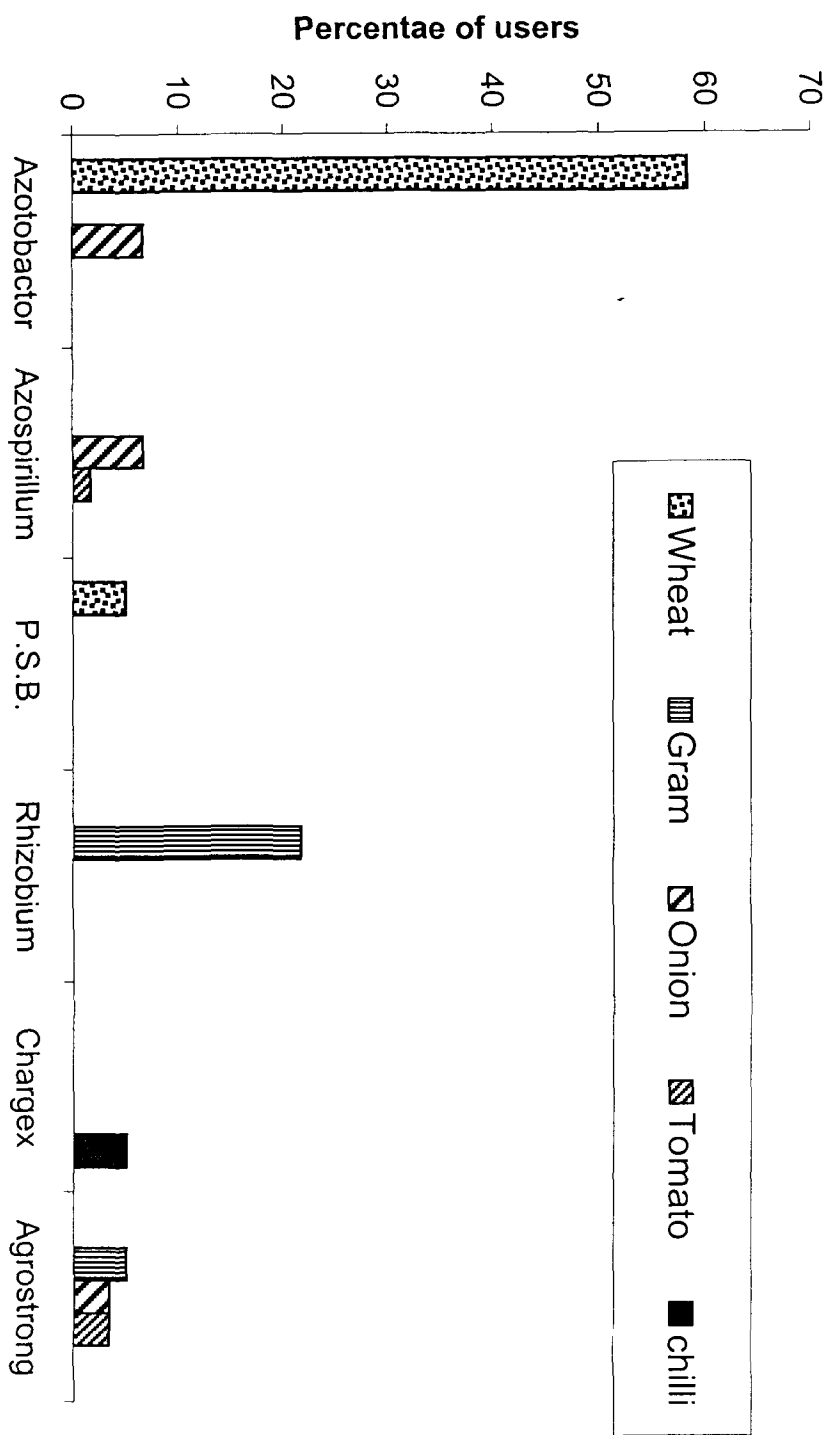


Fig. 5 : Extent of use of biofertilizers by sample farms in rabi season (2002-2003)

5.2.2. Gram

The biofertilizers like *Rhizobium* and Agrostrong were utilized for gram crop. *Rhizobium* was used in powder form while Agrostrong was utilized in liquid form.

In case of *Rhizobium*, the biofertilizer use was 542 gms per hectare which was less than recommendation by 45.80 per cent and use of Agrostrong was 365 ml per hectare which was less than recommendation by 27.00 per cent. The *Rhizobium* and liquid biofertilizer viz; Agrostrong was used by about 22 per cent and 5 per cent of sample farmers, respectively for gram crop on their farms

5.2.3. Rabi onion

Both Azospirillum and Azotobacter were used in powder form and Altrabio was utilized in liquid form for rabi onion on sample farms. The per hectare use of Azospirillum, Azotobacter and Altrabio was 1083 gms, 690 gms and 250 ml which was less than recommended dose by 13.36 , 44.80 and 50.00 per cent, respectively. The liquid biofertilizer Altrabio was used by only 3.33 per cent of sample farms while Azospirillum and Azotobacter biofertilizer was used by 6.67 per cent of sample farmers each for rabi onion.

5.2.4. Tomato

The Azospirillum biofertilizer was used in powder form and Agrostrong biofertilizer was used in liquid form for tomato crop. The application of Azospirillum was 1250 gms per hectare which



The plate of Phosphate solubalizing bacteria (PSB)

was a quite equal to the recommended dose. The application of Agrostrong was 330 ml per hectare which was less than the recommendation by 34.00 per cent. It was observed that only 1.67 per cent of sample cultivators had used Azospirillum and the liquid biofertilizer agrostrong was used by 3.33 per cent of sample cultivators indicating poor spread of biofertilizers among the sample farmers.

5.2.5. Chilli

The *Chargex* biofertilizer was used in liquid form for chilli cultivation. The per hectare use of *Chargex* biofertilizer was 250 ml which was more than the recommended dose by 66.67 per cent. In case of chilli crop, liquid biofertilizer *Chargex* was used by about 5 per cent of sample cultivators on their farms.

To sum up , It can be said that the percent of users of biofertilizers for rabi crops was observed to be low in the area under study. It is also noted that by and large per hectare use of biofertilizers for rabi crops was less than recommended level by 13 to 50 per cent and use of liquid biofertilizer was more than recommended level by 66.67 per cent. It is seen that 58.33 per cent of sample farms used Azotobacter for wheat crop while only 1.67 per cent of farms used Azospirillum for tomato crop in the area under study

5.3 Nature and Extent of Biofertilizer Use on Sample Farms for Summer and Annual crops

The information on per hectare actual use, recommended dose and extent of gap between actual use and recommended dose of biofertilizers for summer and annual crops during the year 2002-03 has been presented in Table 5.3. The extent of use of biofertilizers by sample farms for summer and annual crops is graphically shown in Fig. 6.

5.3.1. Chilli

The liquid biofertilizer like *Chargex* was observed to be used for summer chilli. The use of liquid biofertilizer was 250 ml per hectare which was more than the recommended level by 66.67 per cent. The liquid biofertilizer *Chargex* was used for chilli crop by about 5 per cent of sample cultivators on their farms.

5.3.2. Brinjal

The Azospirillum biofertilizer was used in powder form for brinjal. The application of biofertilizer was 1250 gms per hectare which was equal to the recommended dose. The liquid biofertilizer like *Chargex* was also used for brinjal. The per hectare use of liquid biofertilizer was 180 ml which was more than the recommended level by 20.00 per cent. The use of these two biofertilizers was observed in the range of 4 to 10 per cent of the sample farmers in the area under study.

5.3.3. Sugarcane

Both Azotobacter and phosphate solubilizing bacteria (*P.S.B.*) were used in powder form and Agrostrong biofertilizer was used in liquid form for sugarcane cultivation on sample farms.

The per hectare use of Azotobacter and phosphate solubilizing bacteria was 3755 gms and 5553 gms which was less than the recommendation by 24.90 per cent and 25.96 per cent, respectively and the use of Agrostrong the liquid biofertilizer was 564 ml per hectare which was more than the recommended level by 12.80 per cent. Azotobacter and *P.S.B.* was used by 11.67 and 28.34 per cent of sample cultivators, respectively. The liquid biofertilizer Agrostrong was used by 11.67 per cent of sample cultivators for raising sugarcane on their farms.

To sum up, it can be said that per hectare use of Azotobacter and *P.S.B.* was less than recommended level in case of sugarcane. And per hectare use of *Chargex* for chilli and brinjal and agrostrong for sugarcane was more than the recommended level. Interestingly, the use of Azospirillum for brinjal was equal to the recommended level. The most striking point noted is that the percent of users of biofertilizers for commercial crops such as chilli, brinjal and sugarcane ranged between 3.34 per cent and 28.34 per cent of sample farms in the area under study. This has indicated the par spread of biofertilizers for crop production in the area under study.



The plate of Liquid biofertilizer chargex

Table 5.3 Nature and extent of biofertilizer use on sample farms for summer and annual crops (2002-03)

Sr. No	Name of crop	Name of biofertilizer	Form of use	No. of users	% of users	Actual dose gms/ha	Recommended dose (gms/ ha)	Actual gap in use	% excess or debit
1	Chilli	Chargex	Liquid	3	4.99	250 ml	150 ml	+100 ml	66.67
2	Brinjal	Azospirillum	Powder	2	3.34	1250	1250	-	-
		Chargex	Liquid	6	9.99	180 ml	150 ml	+ 30 ml	20.00
3	Sugarcane	Azotobacter	Powder	7	11.67	3755	5000	-1245	-24.90
		P. S. B.	Powder	17	28.34	5553	7500	-1947	-25.96
		Agrostrong	Liquid	7	11.67	564 ml	500 ml	+ 64 ml	12.80

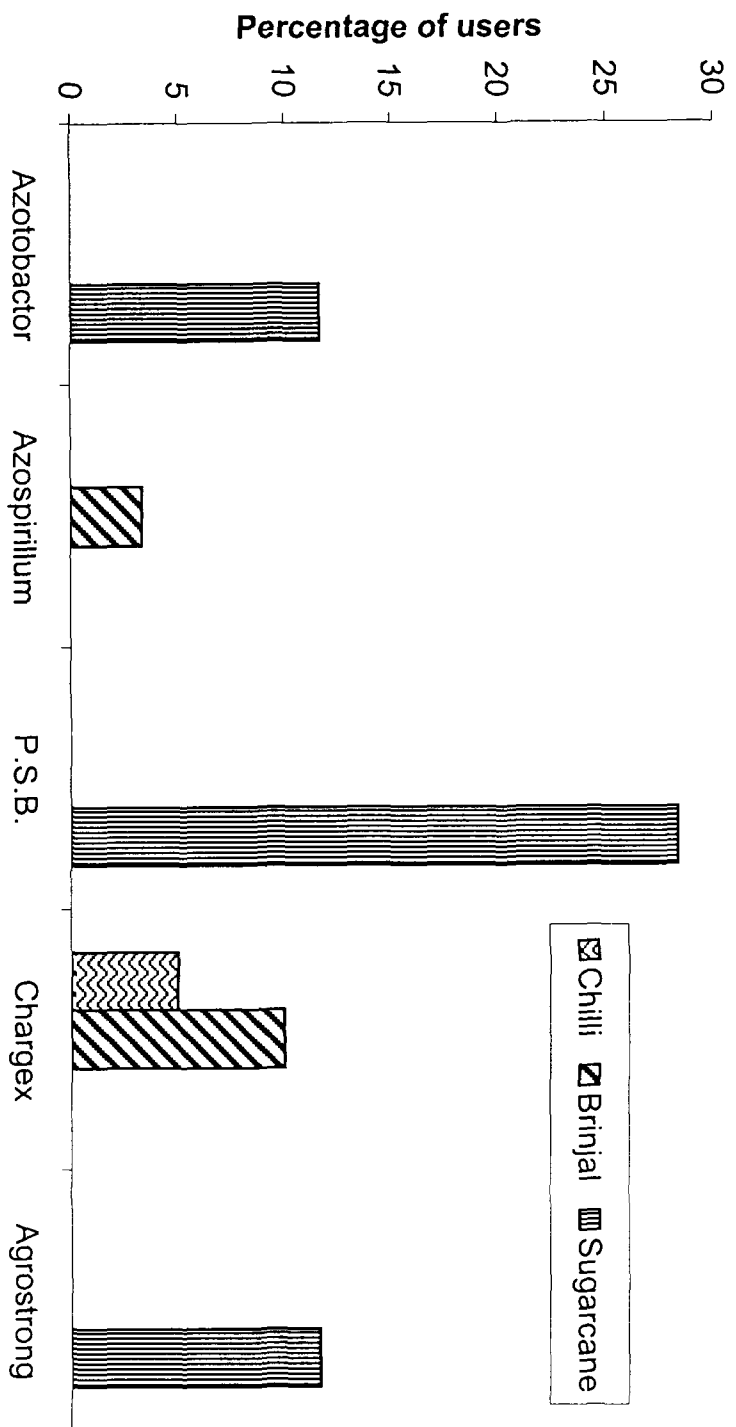


Fig. 6 : Extent of use of biofertilizers by sample farms in summer season and annual crop (2002-2003)

5.4 Effects of Biofertilizer Use on the Productivity of Kharif Crops

The per hectare productivity of biofertilizer used and non-used crops have been worked out and compared with each other so as to assess the effects of biofertilizer use on productivity of crops in case of kharif crops. The details are presented in Table 5.4

5.4.1. Bajra

An average productivity of biofertilizer users and non-users was 34.31 and 26.09 quintals of bajra per hectare, respectively. The productivity differential was 8.22 quintals per hectare. The productivity has been increased by 31.12 per cent due to use of biofertilizers, viz., *Azotobacter*, *Azospirillum* and PSB, while the gross returns showed an increase by about 40.00 per cent

5.4.2. Tur

An average productivity of biofertilizer users and non-users was 19.80 and 16.27 quintals for tur per hectare respectively. The productivity differential was 3.53 quintals per hectare. The productivity showed an increase by 21.69 per cent due to use of biofertilizers like *Rhizobium* and *Chargex*.

5.4.3. Soybean

An average productivity of soybean on the farms of biofertilizer users and non-users was 22.65 and 16.09 quintals per hectare respectively. The productivity differential came to 6.56

quintals per hectare. The productivity of soybean has been increased by 40.77 per cent due to use of biofertilizers like *Rhizobium* and PSB, while the rise in gross returns were to be the extent of 33.39 per cent.

5.4.4. Groundnut

An average productivity of groundnut in the case of biofertilizer users and non-users was 21.79 and 18.31 quintals per hectare respectively. The productivity differentials worked out to 3.48 quintals per hectare showing an increase by 19.00 per cent due to use of biofertilizers like *Rhizobium*, PSB and *Chargex* in the area under study.

5.4.5. Onion

An average productivity of onion on the farms of biofertilizer users and non-users was 246.67 and 220.78 quintals per hectare, respectively. The productivity differentials came to 25.89 quintals per hectare i.e. 11.72 per cent more due to use of biofertilizer like *Azospirillum*.

To summarize, it can be said that in absolute terms, per hectare difference in productivity of onion crop was more by 25.89 quintals on biofertilizer user farms than the non-user farms. Such difference in productivity due to use of biofertilizer was 8.22 qtls in Bajra, 6.56 qtls in soybean, 3.53 qtls in tur and 3.48 qtls in groundnut. As regards percentage increase in productivity, it was 40.77, 31.12, 21.69, 19.00 and 11.72 per cent in case of soybean, bajra, tur, groundnut and onion crops, respectively. This has clearly

Table 5.4 Effect of biofertilizer use on the productivity of *kharif* crops(2002-03)

Sr. No.	Biofertilizer user			Biofertilizer non user		Difference in productivity (q/ha)	Percentage increase	
	Name of crop	Av. productivity (q/ha)	Gross returns (Rs.)	Average productivity (q/ha)	Gross returns (Rs)		Average productivity (q/ha)	Gross returns
1	Bajra	34.31	23425.38	26.09	16743.48	8.22	31.12	39.90
2	Tur	19.80	30499.17	16.27	24663.64	3.53	21.69	23.66
3	Soybean	22.65	32625.31	16.09	24475.54	6.56	40.77	33.39
4	Groundnut	21.79	32072.65	18.31	26683.77	3.48	19.00	20.19
5	Onion	246.67	112991.67	220.78	109078.13	25.89	11.72	3.58

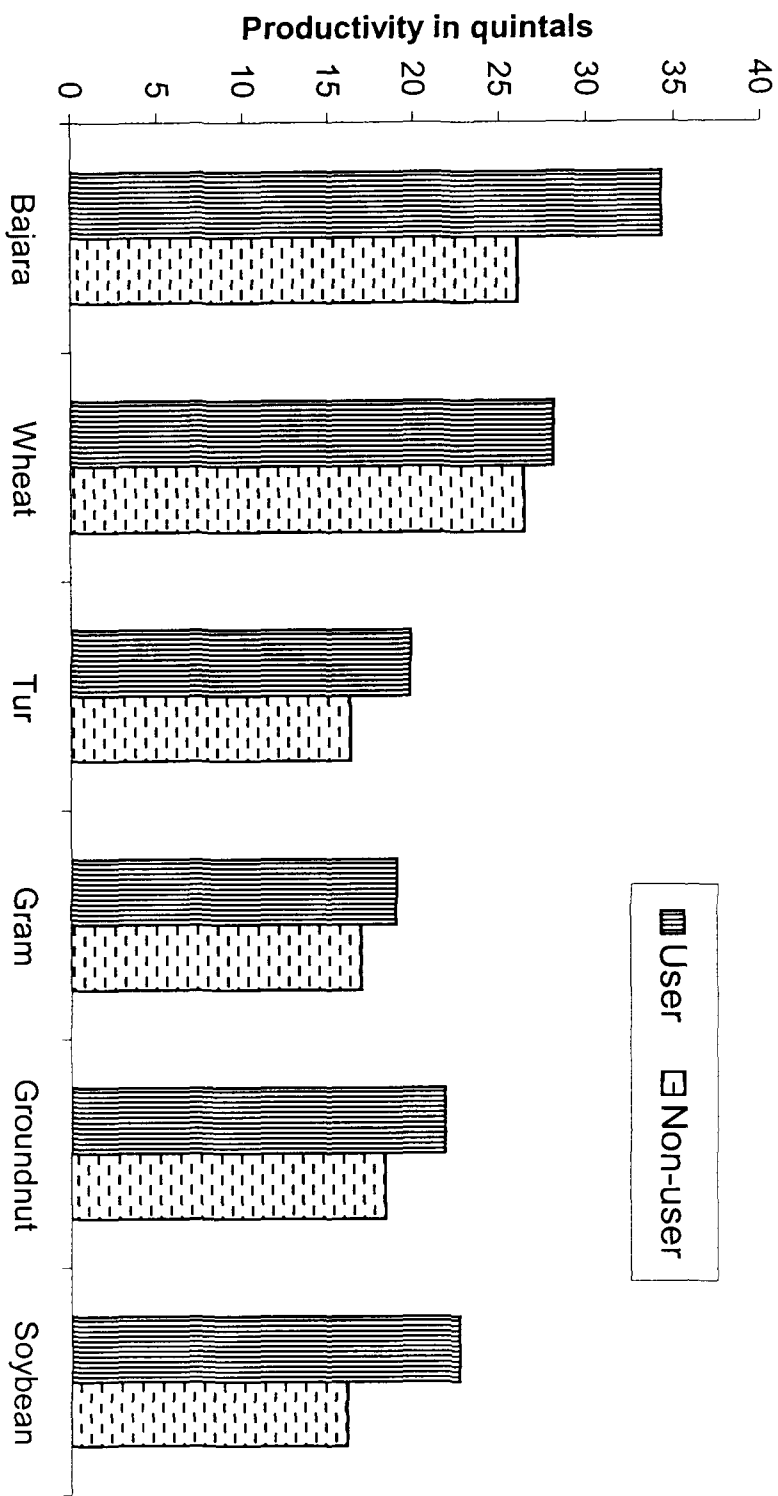


Fig. 7 : Per hectare productivity of cereals, pulses and oil seed crops on the farms of biofertilizer users and non-users

shown the positive impact of biofertilizer use on the productivity of kharif crops in the area under study.

5.5 Effects of Biofertilizer Use on the Productivity of Rabi, Summer and Annual Crops

The average productivity of rabi, summer and annual crops in quintals per hectare of biofertilizer users and non-users has been worked out and compared with each other for their differentials. The details are presented in Table 5.5. Per hectare productivity of selected cereals, pulses and oil seed crops on the farms of biofertilizer users and non-users is graphically presented by way of a bar graph in Fig. 7.

5.5.1. Wheat

The average productivity of wheat on the farms of biofertilizer users and non-users was 28.13 and 26.44 quintals per hectare, respectively. The productivity differentials was 1.69 quintals per hectare i.e. 6.77 per cent more due to use of biofertilizers like Azotobacter and PSB on user farms.

5.5.2. Gram

The average productivity of gram in the case biofertilizer users and non-users was 18.97 and 16.91 quintals per hectare respectively. The productivity differentials was 2.06 quintals per hectare i.e. 1.21 per cent more due to use of

biofertilizers like *Rhizobium* and Agrostrong. At the same time, an increase in the gross returns per hectare was 11.58 per cent.

5.5.3. Tomato

The average productivity of tomato was 222.50 and 220.00 quintals per hectare on the farms of biofertilizer users and non-users, respectively.. The productivity differentials came to 2.50 quintals per hectare i.e. 1.13 per cent more due to use of biofertilizers like Azospirillum and Agrostrong in the area under study.

5.5.4. Chilli

The average productivity of chilli on the farms of biofertilizer users and non-users was 61.67 and 53.33 quintals per hectare, respectively i.e. 8.34 quintals more than the non-users. In other words, increase in productivity was by 15.63 per cent due to use of liquid biofertilizer like *Chargex* in raising chillies.

5.5.5. Brinjal

The average productivity of brinjal on the farms of biofertilizer users and non-users was 255.00 and 253.50 quintals per hectare, respectively i.e.1.50 quintals more than the non-users. The productivity was increased by 0.59 per cent due to use of biofertilizers like Azospirillum and *Chargex* in the area under study.

Table 5.5 Effect of biofertilizers use on the productivity of rabi crops, summer and annual crops(2002-03)

Sr. No.	Biofertilizer user			Biofertilizer non user		Difference in productivity (q/ha)	Percentage increase	
	Name of crop	Av. productivity (q/ha)	Gross returns (Rs)	Av. productivity (q/ha)	Gross returns (Rs)		Av. productivity (q/ha)	Gross returns
1	Wheat	28.13	21514.92	26.44	20799.36	1.69	6.77	3.44
2	Gram	18.97	35895.36	16.91	32167.73	2.06	1.21	11.58
3	Tomato	222.50	93437.50	220.00	79900.00	2.50	1.13	16.94
4	Chilli	61.67	37083.33	53.33	31916.67	8.34	15.63	16.18
5	Brinjal	255.00	117833.33	253.50	101200.00	0.59	16.43	1.50
6	Sugarcane	1272.60	99406.93	969.18	75609.32	303.42	31.30	31.47

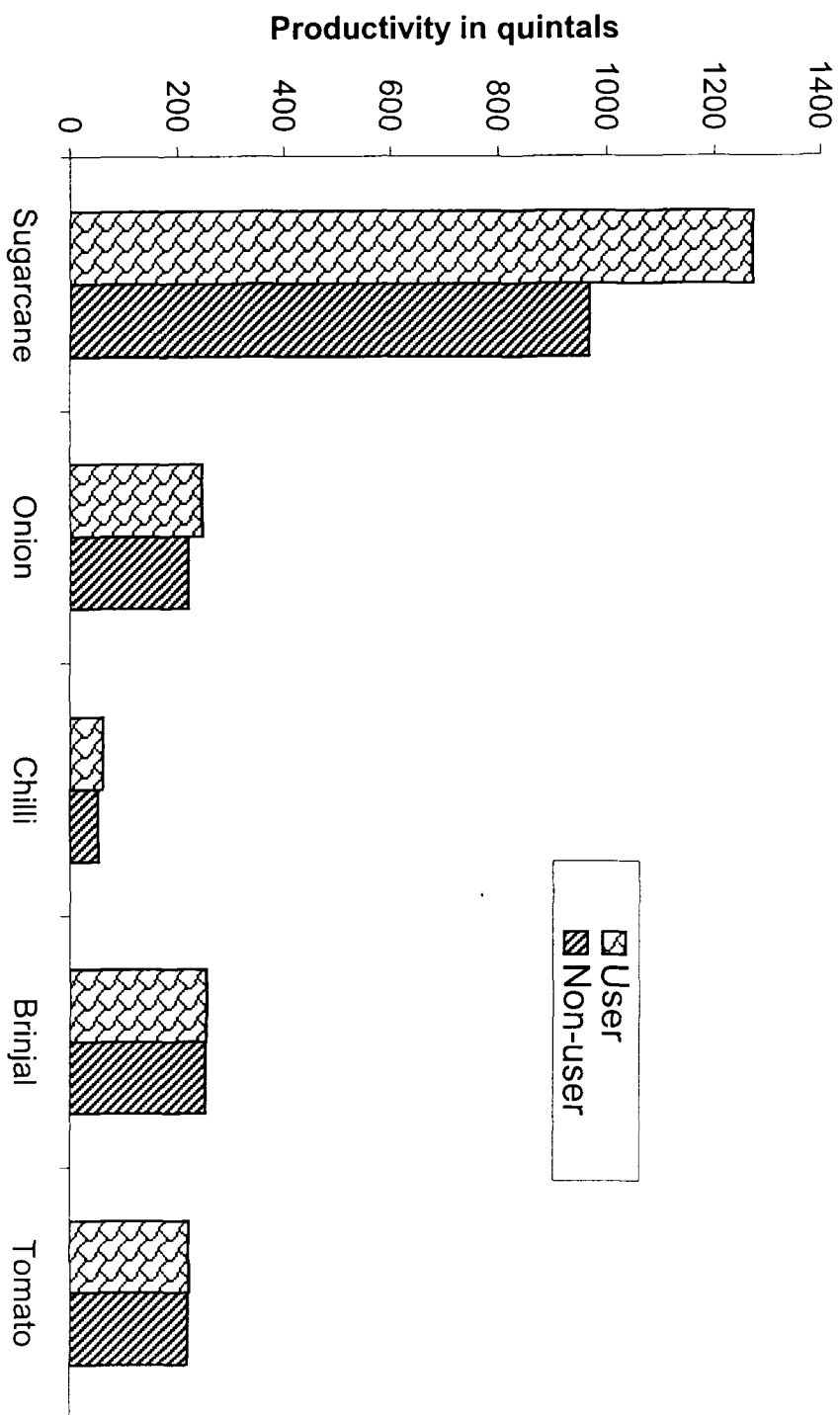


Fig. 8 : Per hectare productivity of sugarcane and vegetable crops on the farms of biofertilizer users and non-users

5.5.6. Sugarcane

The average productivity of sugarcane on the farms of biofertilizer users and non-users was 1272.60 and 969.18 quintals per hectare, respectively i.e. 303.42 quintals more than the non-users. The productivity was increased by 31.30 per cent due to use of biofertilizers like Azotobacter, PSB and Agrostrong in the area under study.

Per hectare productivity of sugarcane and vegetable crops is graphically shown in fig. 8.

To sum up , it can be said that in absolute term, per hectare difference in productivity of sugarcane crop was more by 303.42 quintals on biofertilizer user farms than the non-user farms. Such difference in productivity due to use of biofertilizer was 8.34 qtls in chilli, 2.50 qtls in tomato , 2.06 qtls in gram, 1.69 qtls in wheat and 1.50 qtls in brinjal. As regards percentage increase in productivity, it was 31.30, 16.43, 15.63, 6.77, 1.21 and 1.13 per cent in case of sugarcane, brinjal, chilli, wheat, gram and tomato crops, respectively. This has clearly shown the positive impact of biofertilizer use on the productivity of rabi crops in the area under study.

5.6 Per hectare Recommended, Actual use and Gap in the Use of Manures and Fertilizers in Production of Crops and Gap in Yields on Biofertilizer User Farms

Inputs play a significant role for boosting productivity of a crop. The production and productivity of crops depends on the

judicious and balanced use of inputs. The productivity of a crop is primarily influenced by the factors such as manures, biofertilizers, use of nitrogen, phosphorus, potash etc. Besides, there is very often a close complementary relationship among different inputs for increasing production. Therefore, balanced use of all these resources upto the recommended levels is very important. In the light of a specific relationship between inputs and output of biofertilizer used crops, the data were analysed further to work out the gaps in the actual use levels and recommended levels of inputs and output of biofertilizer used crops on per hectare basis. The results obtained from the analysis are presented in Table 5.6.

It is seen that the per hectare use of manure was less than recommended level in all the crops except gram on the biofertilizer user farms. The gap in use of manure was maximum in soybean (-89.80 per cent) followed by tomato (-72.50 per cent), wheat (-61.03 per cent), chilli (-51.66 per cent), brinjal (-51.34 per cent) and sugarcane (-41.48 per cent).

The actual use of nitrogen was more than recommended level for tur, gram and groundnut by 47.76, 44.96 and 42.64 per cent, respectively, while actual use of phosphorus

Table 5.6 Per hectare recommended, actual use and gap in the use of manures and fertilizers in production of crops and gap in yields on biofertilizer user farms (2002-03)

Name of the crop	No. of cultivators	Manure (qtls)			Chemical fertilizers (kg)									Yield (qtls)		
		Recom mended	Actual use	Per cent Gap	Recommended			Actual use			Per cent Gap			Reco mme nded	Actual	Per cent Gap
					N	P	K	N	P	K	N	P	K			
Bajra	10	35	26.31	-24.83	60	30	30	33.92	22.38	6.92	-43.47	-25.40	-76.93	30	34.31	14.37
Wheat	37	35	13.64	-61.03	80	40	30	59.63	37.49	10.59	-25.46	-6.27	-64.70	35	28.13	-19.63
Tur	11	30	14.81	-50.63	25	50	-	36.94	45.76	17.72	+47.76	-8.48	-	18	19.80	10.00
Gram	16	30	34.02	+13.40	25	50	-	36.24	37.94	10.62	+44.96	-24.12	-	20	18.97	-5.15
Groundnut	24	35	22.91	-34.54	25	50	-	35.66	45.11	13.82	+42.64	-9.78	-	22	21.79	-0.95
Soybean	18	35	3.57	-89.80	50	75	-	46.12	46.53	16.99	-7.76	-37.96	-	25	22.65	-9.40
Sugarcane	31	100	58.52	-41.48	250	115	115	116.28	81.14	38.00	-53.49	-29.44	-66.96	1000	1272.60	27.26
Onion	11	50	35.00	-30.00	100	50	50	77.71	47.54	28.21	-22.29	-4.92	-43.58	250	246.67	-1.33
Chilli	6	50	24.17	-51.66	100	50	50	77.93	97.08	45.00	-22.07	+94.16	-10.00	60	61.67	2.78
Brinjal	8	50	24.33	-51.34	100	50	50	62.83	73.67	21.33	-37.17	+47.34	-57.34	300	255.00	-15.00
Tomato	3	50	13.75	-72.50	100	50	50	61.56	32.81	5.94	-38.44	-34.38	-88.12	250	228.75	-8.50

was more than recommended level for vegetable crops like chilli and brinjal by 94.16 and 47.34 per cent, respectively. The per hectare use of potash was less than recommended level except for tur, gram, groundnut and soybean. The per hectare yield obtained was more than the recommended level by 14.37, 10.00 and 27.26 per cent in the case of bajra, tur and sugarcane, respectively on the farms of biofertilizer users in the area under study.

To conclude, it can be said that per hectare yield of bajra, tur and sugarcane was more than the recommended level, even though the use of manures and fertilizers was less than the recommended levels, in case of biofertilizer user farms.

5.7 Per hectare Recommended, Actual use and Gap in the Use of Manures and Fertilizers in Production of Crops and Gap in the Yields on Biofertilizer Non-user Farms.

In the light of specific relationship between inputs and output of biofertilizer non-used crops, the data have been analysed further to work out the gaps in the actual use levels and recommended levels of inputs and output of biofertilizer non-used crops on per hectare basis. The results obtained from the analysis are presented in Table 5.7.

Table 5.7 Per hectare recommended, actual use and gap in the use of manures and fertilizers in production of crops and gap in yields on biofertilizer non- user farms (2002-03)

Name of the crop	No. of cultivators	Manure (qtls)			Chemical fertilizers (kg)												Yield (qtls)			
					Recommended			Actual use			Per cent Gap									
		Recomm- ended	Actual use	Per cent Gap	N	P	K	N	P	K	N	P	K	Reco- mmen- ded	Actual	Per cent Gap				
Bajra	20	35	21.85	-37.57	60	30	30	23.80	21.55	6.55	-60.28	-28.17	-78.17	30	26.09	-13.03				
Wheat	34	35	16.16	-53.83	80	40	30	48.00	35.44	12.8	-40.05	-11.40	-57.33	35	26.44	-24.46				
Tur	14	30	19.09	-36.37	25	50	-	44.30	56.82	15.91	-77.08	13.64	-	18	16.27	-9.61				
Gram	18	30	24.82	-17.27	25	50	-	33.30	38.48	11.84	-33.36	-23.04	-	20	16.91	-15.45				
Groundnut	18	35	15.71	-55.11	25	50	-	47.30	41.66	12.11	-89.24	-16.68	-	22	18.31	-16.77				
Soybean	19	35	4.78	-86.34	50	72	-	39.00	45.6	7.23	-22.06	-36.67	-	25	16.09	-35.64				
Sugarcane	37	100	64.44	-35.56	250	115	115	228	107.63	104	-8.66	-6.41	-9.56	1000	696.18	-30.38				
Onion	11	50	33.59	-32.82	100	50	50	68.60	56.17	25.55	-31.41	-12.34	-48.90	250	220.78	-11.69				
Chilli	8	50	21.90	-56.20	100	50	50	94.40	65.83	46.79	-5.60	-31.66	-6.42	60	53.33	-11.12				
Brinjal	8	50	24.50	-51.00	100	50	50	63.90	78.06	10.06	-36.06	-56.12	-79.88	300	253.50	-15.50				
Tomato	7	50	30.00	-40.00	100	50	50	95.80	81.33	0	-4.17	-62.66	-100.00	250	220.00	-12.00				

In case of biofertilizer non-user farms, the per hectare use of manures was observed to be less than the recommended levels for all crops in the area under study. However, the per hectare use of nitrogen was more than the recommended level for tur, gram and groundnut by 77.08, 33.36 and 89.24 per cent, respectively. The gap in the use of nitrogen was maximum for groundnut by 89.24 per cent.

The per hectare use of phosphorus was less than recommended for bajra, wheat, gram, groundnut, soybean and sugarcane by 28.17 , 11.40 , 23.04 , 16.68 , 36.67 and 6.41 per cent, respectively. The gap in the use of potash was maximum for tomato crop and the per hectare yield of all crops was less than the recommended level.

To summerize, it can be said that. actual use of manures was less than the recommended level in all the crops. Percentage gap of manure, nitrogen, phosphorus and potash was higher in soybean, groundnut, brinjal and tomato, respectively. The actual yield received by biofertilizer non-user farms is observed to be less than recommended level due to low use of manures and fertilizers.

5.8 Per hectare Costs and Returns of Kharif Crops on Biofertilizer User and Non-user Farms

The estimates of the per hectare output, gross income and profit at different cost levels of kharif crops are given in Table 5.8.

5.8.1. Bajra

The productivity of bajra crop on biofertilizer user farms has increased by 31.12 per cent than non-user farms. As a result, the gross returns from this crop were higher (Rs. 23425/-) on user farms as against Rs. 16743/- on non-user farms. The cost A, B and C were higher by 19.70, 27.07 and 27.19 per cent, respectively on biofertilizer user farms than the non-user farms. The profit at cost A and net returns i. e. profit at cost C were higher by 79.06 and 162.94 per cent, respectively than non-user farms. B:C ratio for bajra crop on biofertilizer user farms was 1.21 as compared to 1.10 on non-user farms.

5.8.2. Tur

The per hectare cost of cultivation of tur at cost A, cost B and cost C levels was Rs.10406/-, Rs. 17185/- and Rs. 17577/-, respectively, on the biofertilizer user farms. For non-user farm, the per hectare cost of cultivation at cost A, cost B and Cost C levels was Rs. 10634/-, Rs. 16295/-, Rs. 16762/-, respectively, indicating that the per hectare production cost for tur was higher on the biofertilizer user farms by 4.86 per cent as compared to the non-

**Table 5.8 Per hectare costs and returns of kharif crops on
biofertilizer user and non-user farms (2002-03)**
(Rs.)

	Particulars	Bajra		Tur	
		Biofertiliz- er users	Non- users	Biofert- ilizer users	Non- users
1	Output (Qtls)	34.31	26.09	19.80	16.27
	% change	31.12		21.69	
2	Gross returns	23425.38	16743.48	30499.17	24663.64
	% change	39.90		23.66	
3	Cost A	13216.64	11042.39	10406.26	10634.15
	% change	19.70		-2.14	
4	Profit at cost A	10208.74	5701.09	20092.91	14029.48
	% change	79.06		43.21	
5	Cost B	18589.00	14628.40	17185.29	16295.12
	% change	27.07		5.46	
6	Profit at cost B	4836.36	2115.08	13313.87	8368.51
	% change	128.66		59.09	
7	Cost C	19301.91	15175.27	17577.14	16762.40
	% change	27.19		4.86	
8	Profit at cost C	4123.47	1568.20	12922.03	7901.24
	% change	162.94		63.54	
9	B:C ratio	1.21	1.10	1.74	1.47
10	per qtl. Cost	494.80	534.09	887.70	1030.09

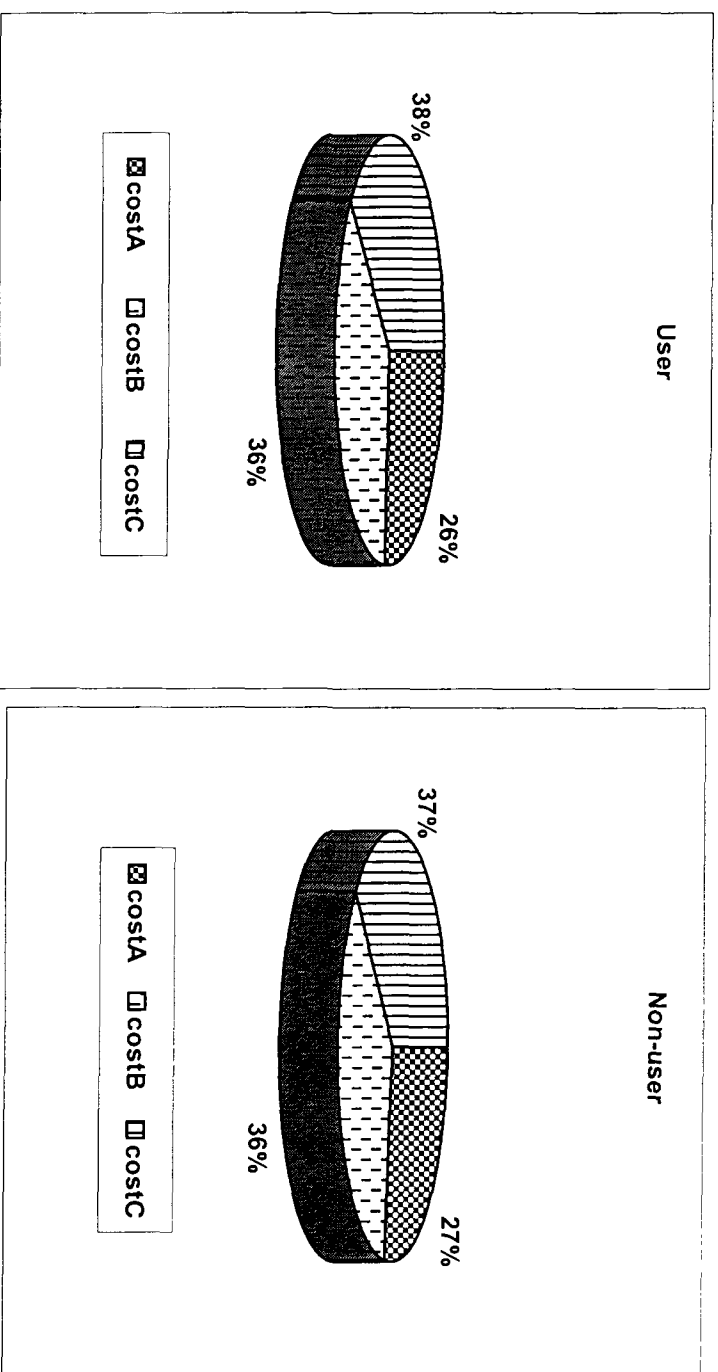


Fig. 9 Per hectare costs on biofertilizer user and non-user farms for bajra crop

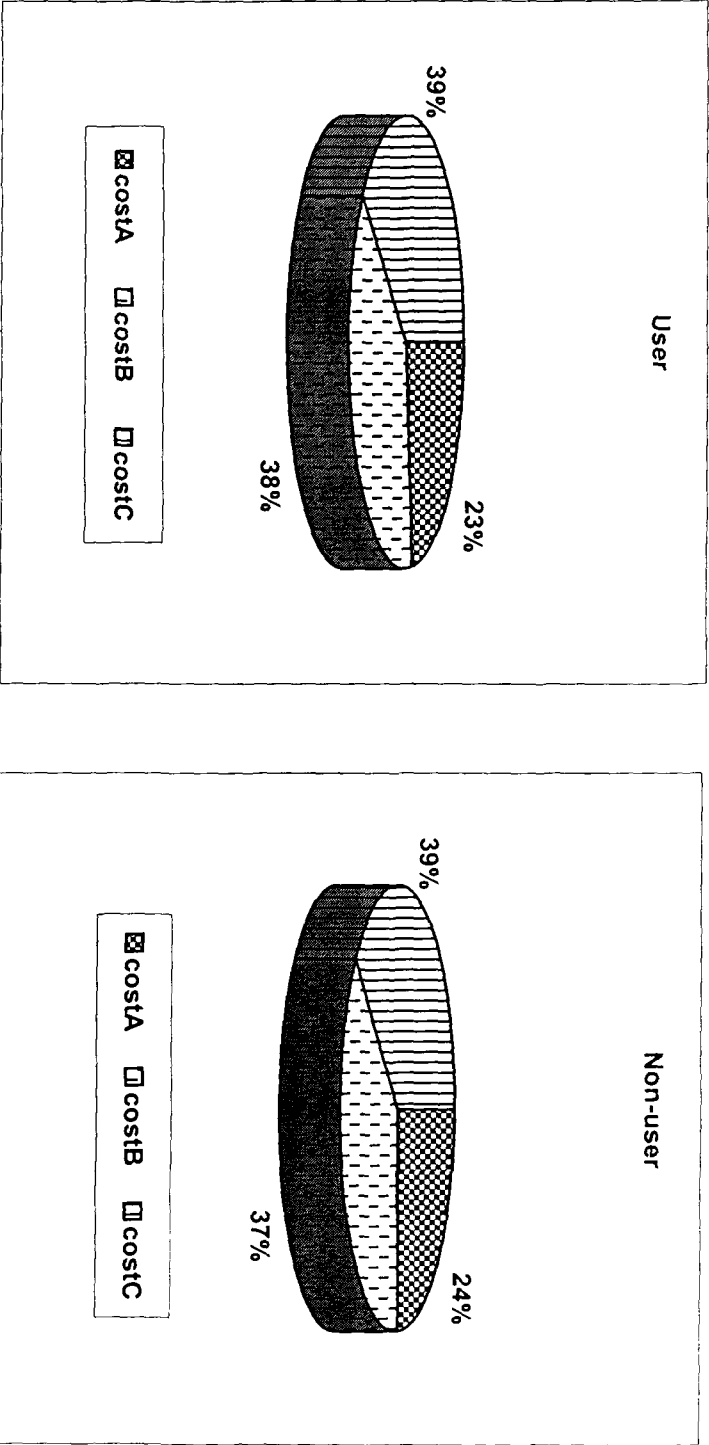


Fig.10 Per hectare costs on biofertilizer user and non-user farms for Tur crop

Table 5.8 : Contd.....

	Particulars	Soybean		Groundnut	
		Biofertilizer user	Non-user	Biofertilizer user	Non-user
1	Output (Qtls)	22.65	16.09	21.79	18.31
	% change	40.77		19.00	
2	Gross returns	32625.31	24475.54	32072.65	26683.77
	% change	33.29		20.19	
3	Cost A	12805.47	11431.91	16545.72	15383.66
	% change	12.01		7.55	
4	Profit at cost A	19819.83	13043.63	15526.93	11300.10
	% change	51.95		37.40	
5	Cost B	19931.90	19889.21	23201.42	20872.65
	% change	18.01		11.15	
6	Profit at cost B	12693.41	7586.33	8871.23	5811.12
	% change	67.31		52.65	
7	Cost C	20722.84	17662.71	25129.09	22671.67
	% change	17.32		10.83	
8	Profit at cost C	11905.46	6812.83	6943.56	4012.09
	% change	74.70		73.06	
9	B:C ratio	1.57	1.39	1.27	1.17
10	per qtl. Cost	907.90	1089.67	1125.53	1204.48

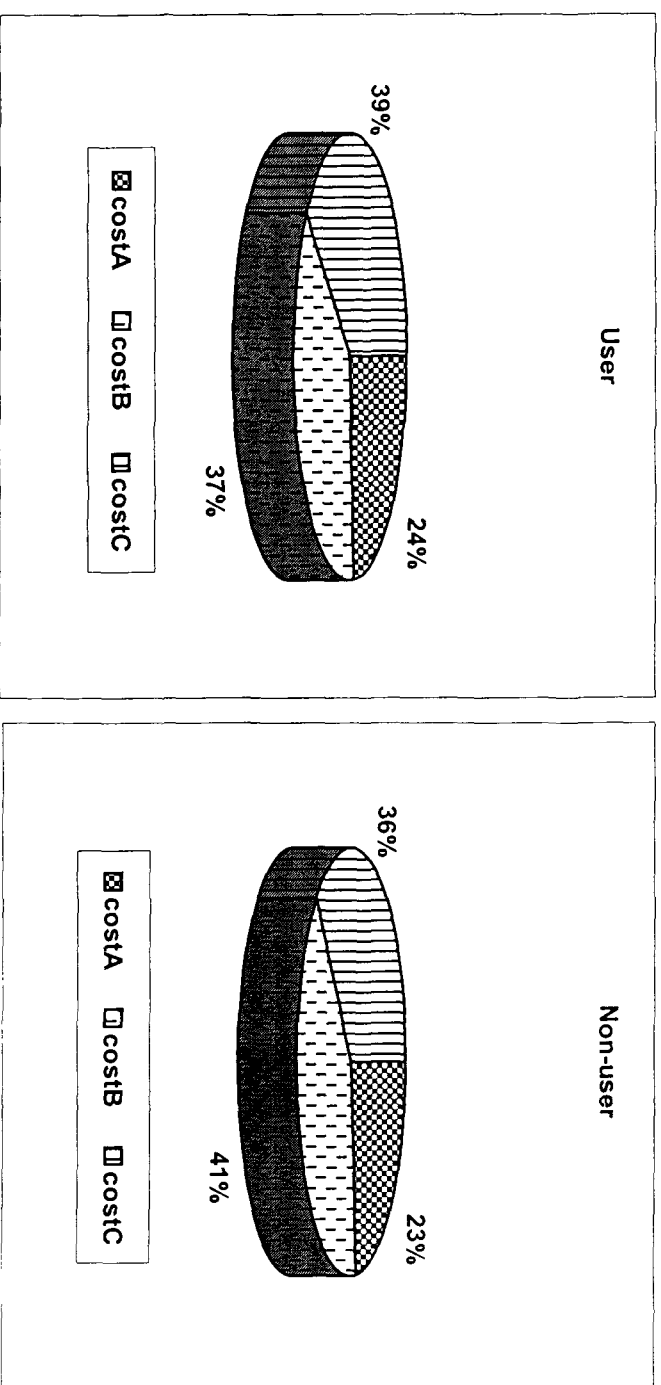


Fig.11 Per hectare costs on biofertilizer user and non-user farms for Soybean crop

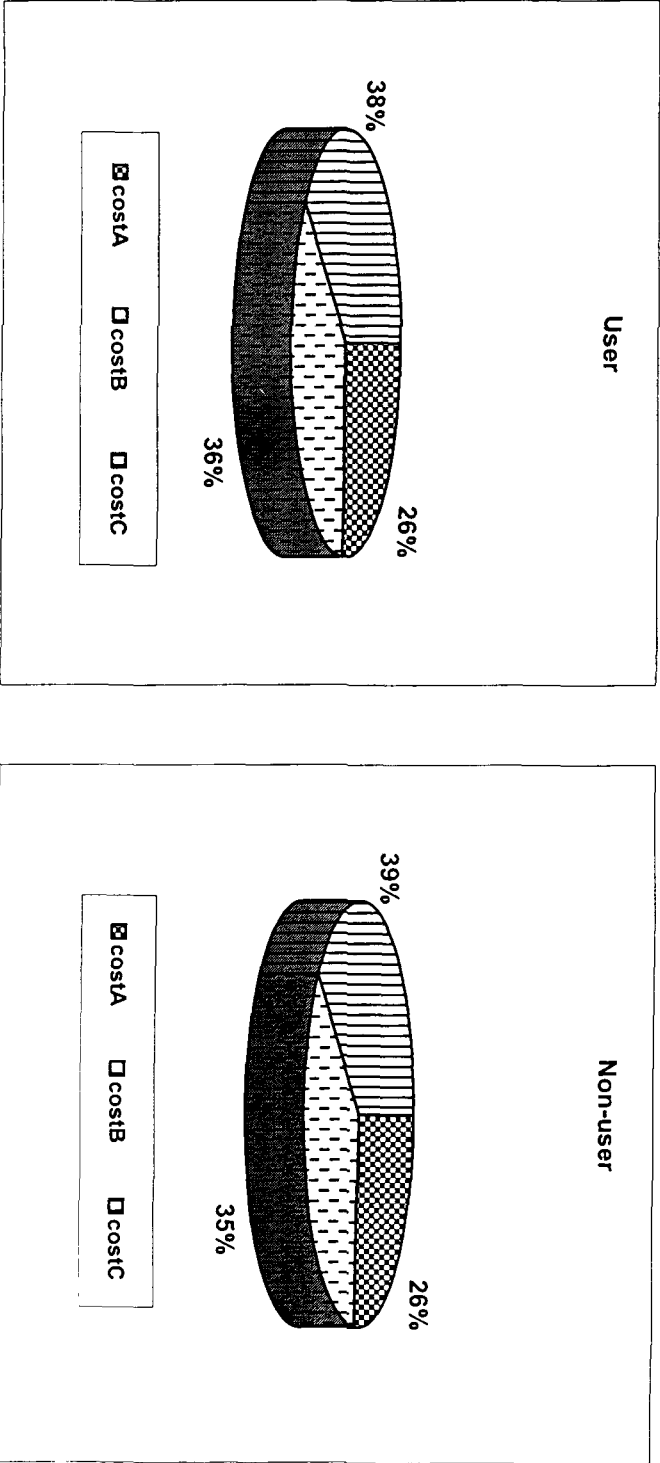


Fig.12 Per hectare costs on biofertilizer user and non-user farms for Groundnut crop

Table 5.8 : Contd.....

	Particulars	Onion	
		Biofertilizer user	Non-user
1	Output (Qtls)	246.67	220.78
	% change	11.72	
2	Gross returns	112991.67	109078.13
	% change	3.56	
3	Cost A	27345.06	26002.56
	% change	5.16	
4	Profit at cost A	85646.61	83075.57
	% change	3.09	
5	Cost B	47668.34	45549.59
	% change	4.65	
6	Profit at cost B	65323.33	63528.54
	% change	2.82	
7	Cost C	49660.21	48752.32
	% change	1.86	
8	Profit at cost C	63331.46	60325.81
	% change	4.98	
9	B:C ratio	2.27	2.23
10	Per qtl. Cost	201.32	216.28

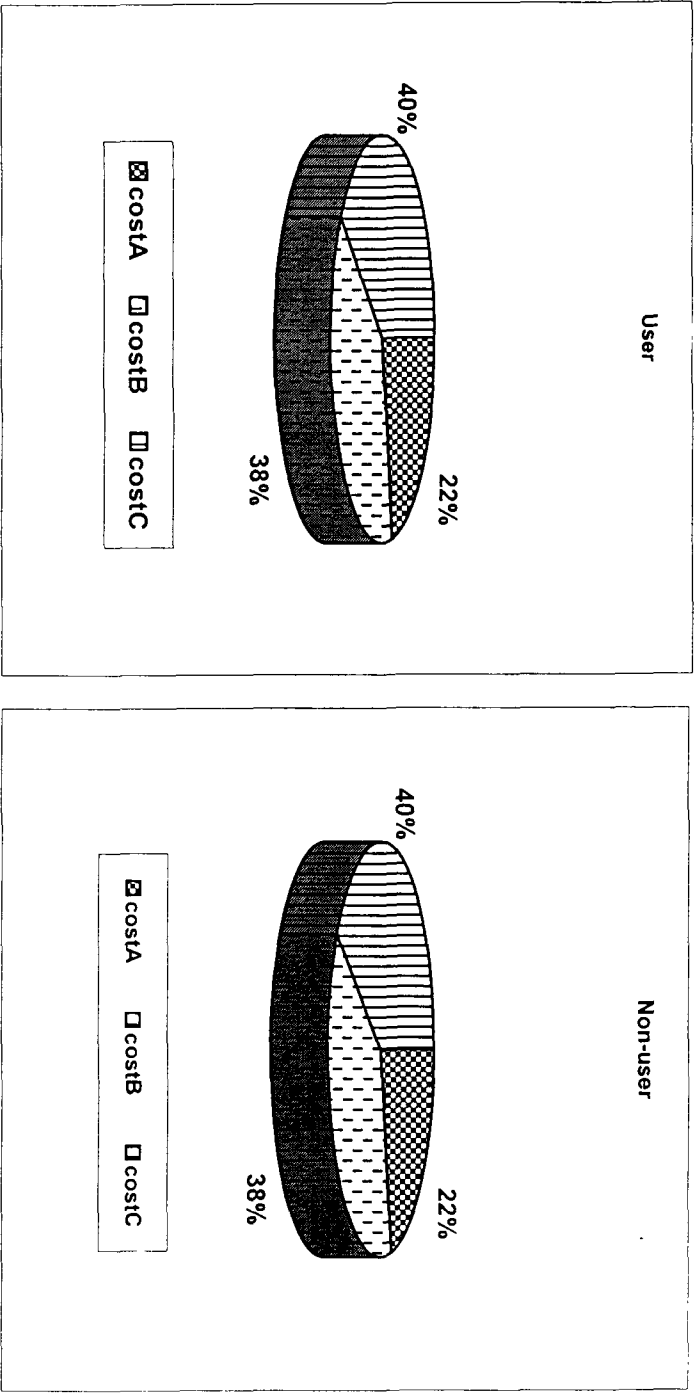


Fig.13 Per hectare costs on biofertilizer user and non-user farms for Onion crop

user farms. The yield of tur crop was higher on the user farms by 21.69 per cent.

5.8.3. Soybean

The per hectare gross returns, profit at cost A, cost B and cost C levels were higher on the biofertilizer user farms than those of non user farms. This was mainly due to high productivity of soybean under biofertilizer user farms (22.65 quintals) as compared to the non user farms (16.09 quintals).

5.8.4. Groundnut

The productivity of groundnut on biofertilizer user farms was higher (21.79 quintals/ha) than that of the non user farms (18.31 quintals/ha). Therefore, gross returns were also higher (Rs. 32072) on biofertilizer user farms than that of the non-user farms (Rs. 26683) i.e by 19.00 per cent.

5.8.5. Onion

The per hectare returns at various cost levels were observed to be higher under the biofertilizer user farms than those of the non-user farms. The per hectare yield was higher on biofertilizer user farms by 11.72 per cent as compared to non user farms.

In sum, it is observed that during kharif season percentage change in output was maximum in soybean crop and

minimum in onion crop. The percentage change in profit at cost C was maximum in bajra crop and minimum in onion crop.

5.9 Per hectare Costs and Returns of Rabi Crops on Biofertilizer User and Non-user Farms

The estimates of the per hectare output, gross income and profit obtained from rabi crops at different cost levels are given in Table 5.9.

5.9.1. Wheat

The productivity of wheat crop on biofertilizer user farms has increased by 6.77 per cent more than the non-user farms. As a results, the gross returns from this crop were higher (Rs. 21515/-) on biofertilizer user farms as against (Rs. 20799/-) on non-user farms. The cost A, B and C were higher by 4.84, 4.34 and 1.70 per cent on the farms of users than the non-users. Also, the profit at cost A and net returns i. e. returns at cost C were higher by 1.55 and 2.33 per cent than non-user farms, respectively. The B:C ratio for wheat crop on biofertilizer user farms was 1.11 as compared to 1.09 on non-user farms

5.9.2. Gram

Average productivity of gram on biofertilizer user farms was more by 1.21 per cent than the non-user farms. The B : C ratio

Table 5.9 Per hectare costs and returns of rabi crops on biofertilizer user and non-user farms (2002-03)

(Rs.)

	Particulars	Wheat		Gram	
		Biofertilizer user	Non-user	Biofertilizer user	Non-user
1	Output (Qtls)	28.13	26.44	18.97	16.91
	% change	6.77		1.21	
2	Gross returns	21514.92	20799.36	35895.36	32167.73
	% change	3.44		11.58	
3	Cost A	12482.11	11905.06	12771.34	11808.30
	% change	4.84		8.15	
4	Profit at cost A	9032.80	8894.30	23124.03	20359.43
	% change	1.55		13.57	
5	Cost B	18360.94	17597.04	20263.59	18489.68
	% change	4.34		9.59	
6	Profit at cost B	3153.97	3102.32	15631.77	13678.05
	% change	1.66		14.28	
7	Cost C	19457.86	19131.60	21004.05	19206.72
	% change	1.70		9.35	
8	Profit at cost C	2057.05	1667.76	14891.31	12961.01
	% change	2.33		14.89	
9	B:C ratio	1.11	1.09	1.71	1.67
10	Per qtl. Cost	686.60	718.09	1102.41	1131.01

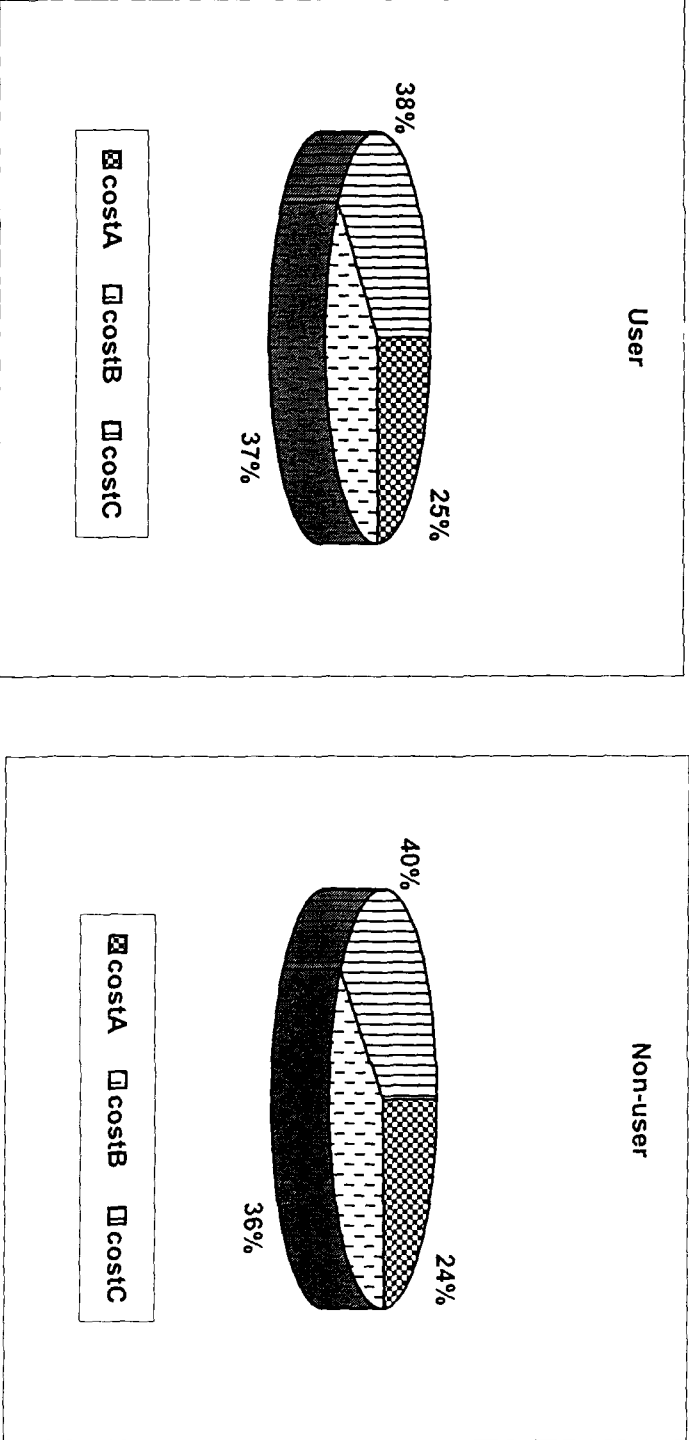


Fig.14 Per hectare costs on biofertilizer user and non-user farms for Wheat crop

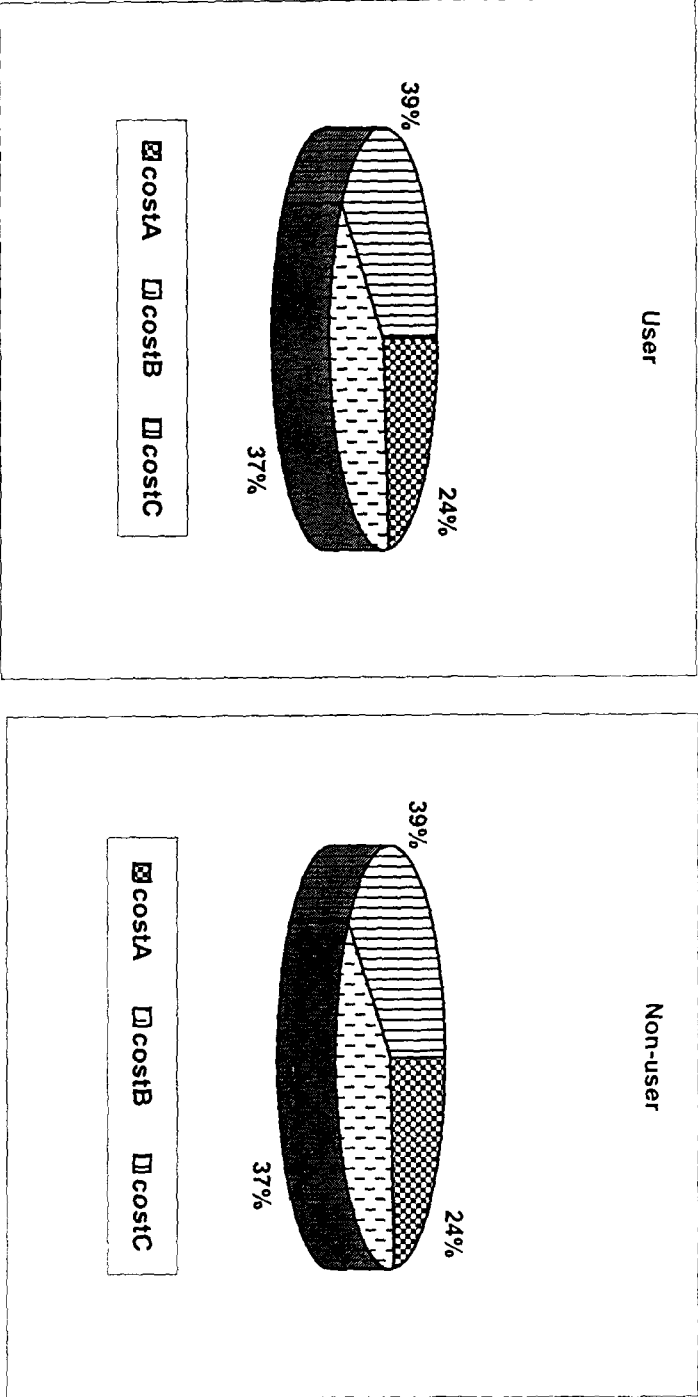


Fig.15 Per hectare costs on biofertilizer user and non-user farms for Gram crop

Table 5.9 : Contd....

	Particulars	Tomato		Chilli	
		Biofertilizer user	Non-user	Biofertilizer user	Non-user
1	Output (Qtls)	222.50	220.00	61.67	53.33
	% change	1.13		15.63	
2	Gross returns	93437.50	79900.00	37083.33	31916.67
	% change	16.94		16.18	
3	Cost A	10665.13	5781.68	15955.24	14111.51
	% change	84.46		13.06	
4	Profit at cost A	82772.36	74118.32	21128.09	17805.16
	% change	11.67		18.66	
5	Cost B	27068.05	22242.12	24844.96	21920.47
	% change	21.69		13.34	
6	Profit at cost B	66369.45	57657.88	12238.37	9996.19
	% change	15.10		22.43	
7	Cost C	27946.17	23802.12	26255.38	23037.14
	% change	17.41		13.96	
8	Profit at cost C	65491.33	56097.88	10827.95	5906.22
	% change	16.74		83.33	
9	B:C ratio	3.38	3.36	1.41	1.39
10	Per qtl. Cost	125.60	108.19	425.76	431.94

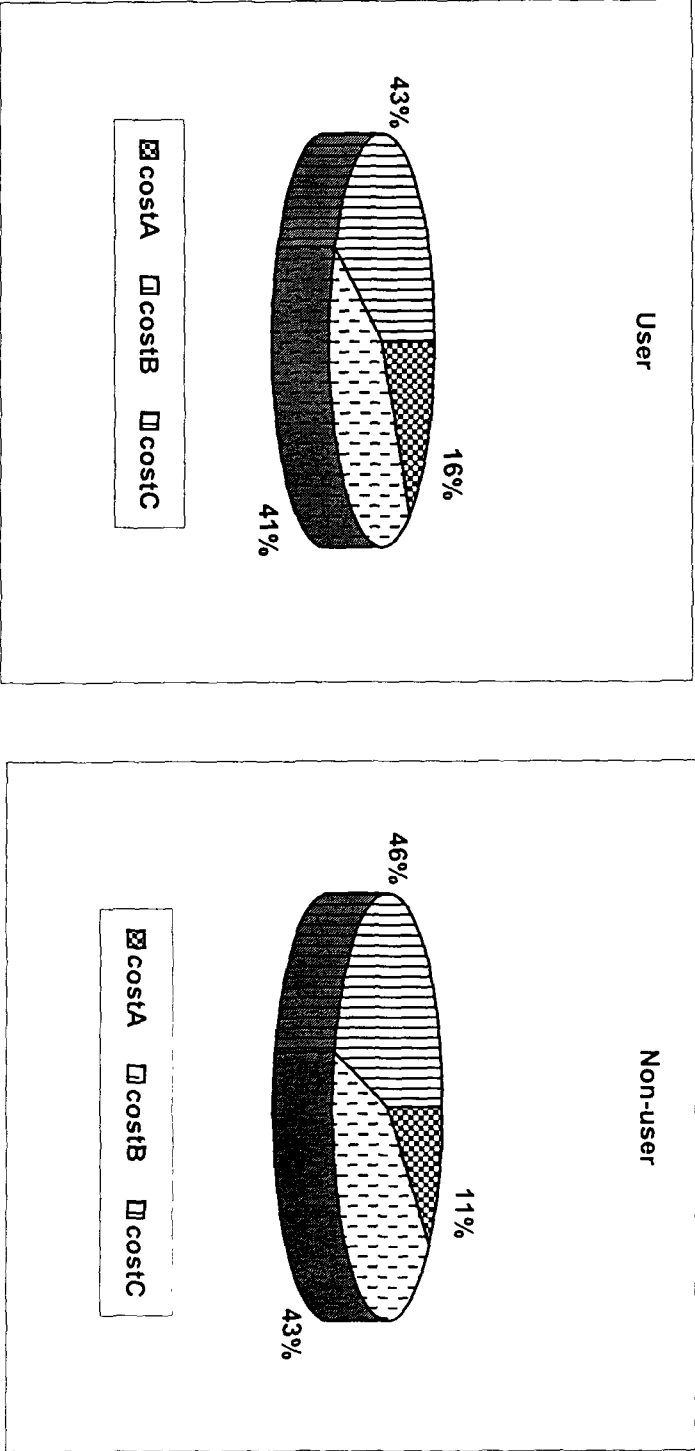


Fig.16 Per hectare costs on biofertilizer user and non-user farms for Tomato crop

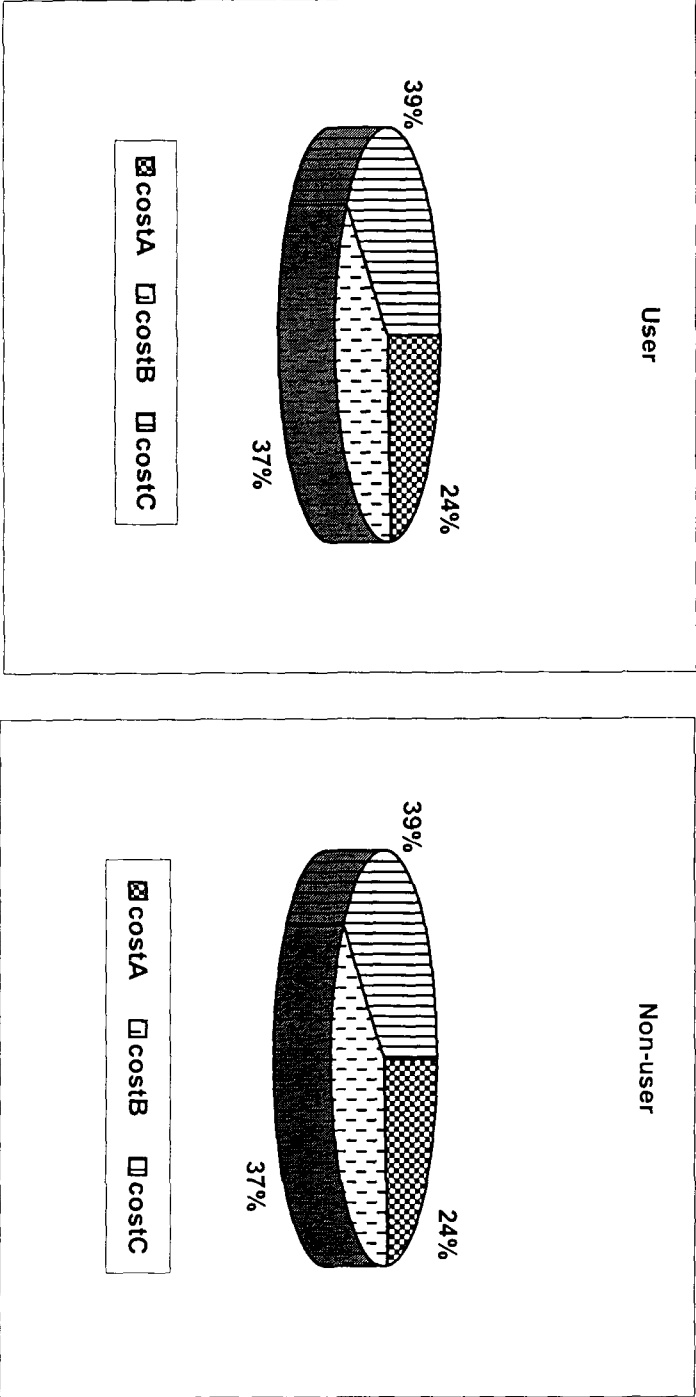


Fig.17 Per hectare costs on biofertilizer user and non-user farms for Chilli crop

on biofertilizer user farms was 1.71 as compared to 1.67 on non-user farms.

5.9.3. Tomato

The per hectare gross returns, profit at cost A, cost B and cost C levels were higher on the biofertilizer user farms than those of non user farms by 16.94, 11.67, 15.10 and 16.74 per cent, respectively. This indicates that the biofertilizer users could get more returns from tomato as compared to their counterparts.

5.9.4. Chilli

The per quintal cost of production in chilli was higher by 1.43 per cent on the farms of biofertilizer non-users as compared to the biofertilizer users. But, the productivity of chilli was observed to be more by 15.63 per cent on biofertilizer user farms as compared to non- users.

In sum, it is concluded that the biofertilizer users could get higher yields in production of rabi crops and therefore higher returns as compared to non-users. This has been indicated by the higher B:C ratios in selected rabi crops on the farms of biofertilizer users as compared to their counterparts.

5.10 Per hectare Costs and Returns of Summer and Annual Crops on Biofertilizer User and Non-user Farms

The estimates of the per hectare output, gross income and profit at different cost levels of summer and annual crops are given in Table 5.10.

5.10.1. Brinjal

It is observed that the productivity of brinjal crop was higher just by 0.59 per cent on biofertilizer user farms than non-user farms. In view of this, the gross returns from this crop was higher by 16.43 per cent on biofertilizer user farms. The estimates of cost at A, B and C were higher by 11.66, 15.86 and 15.58 per cent, respectively on biofertilizer user farms than the non-user farms. The net returns i. e. returns over cost C were higher by 16.83 per cent on biofertilizer user farms. This has been reflected by higher B:C ratio (3.11) on these farms in brinjal.

5.10.2. Sugarcane

The productivity of sugarcane crop on biofertilizer user farms was higher by 31.30 per cent than the non-user farms. As a results, the gross returns from this crop on biofertilizer user farms were higher by 31.47 per cent. Importantly, the B:C ratio in sugarcane production was 1.31 on users farm as compared to 1.30 on non-users farm.

Table 5.10 Per hectare costs and returns of summer and annual crop under biofertilizer user and non-user farms (2002-03)

	Particulars	Brinjal		Sugarcane	
		User	Non-user	User	Non-user
1	Output (Qtls)	255	253.50	1272.60	969.18
	% change	0.59		31.30	
2	Gross returns	117833.33	101200.00	99406.93	75609.32
	% change	16.43		31.47	
3	Cost A	14973.36	13409.23	44606.99	36405.93
	% change	11.66		22.52	
4	Profit at cost A	102859.97	87790.78	54799.94	39203.38
	% change	17.16		39.78	
5	Cost B	36367.25	31388.89	70688.31	54258.59
	% change	15.86		30.28	
6	Profit at cost B	81466.08	69811.11	28718.62	21350.73
	% change	16.69		34.50	
7	Cost C	37585.59	32517.02	75641.10	58195.69
	% change	15.58		29.97	
8	Profit at cost C	80247.75	68682.98	23765.83	17413.63
	% change	16.83		36.47	
9	B:C ratio	3.13	3.11	1.31	1.30
10	Per qtl. Cost	147.39	128.27	55.64	56.06

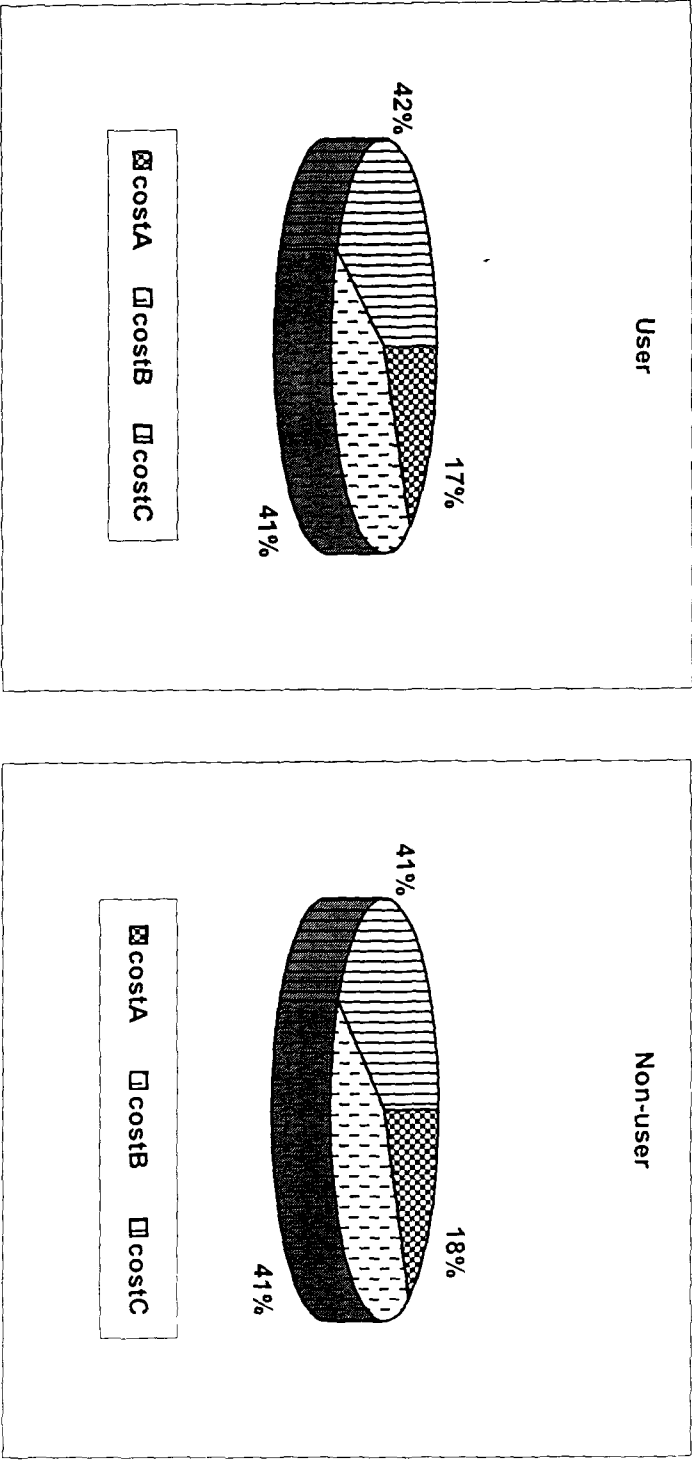


Fig.18 Per hectare costs on biofertilizer user and non-user farms for Brinjal crop

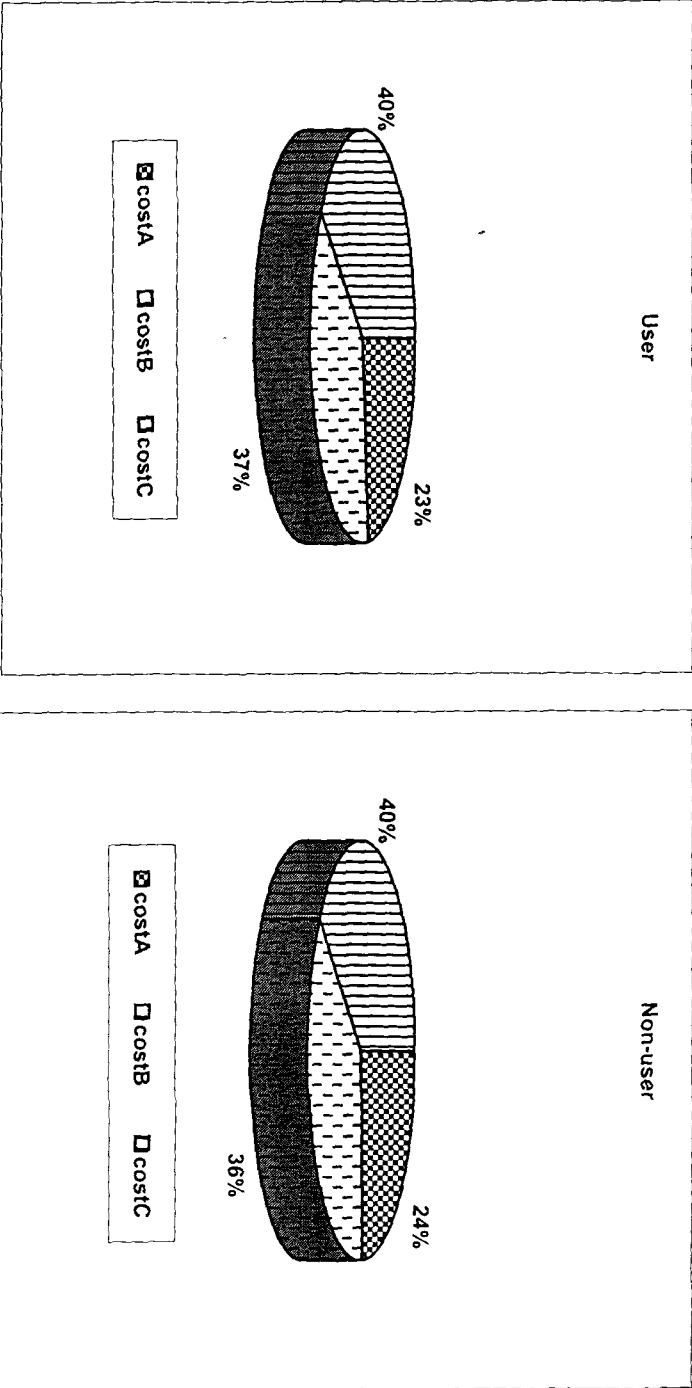


Fig.19 Per hectare costs on biofertilizer user and non-user farms for Sugarcane crop

To conclude, it can be said that the use of biofertilizers for brinjal and sugarcane enable the users to have a bit higher productivity in brinjal and relatively larger productivity in sugarcane. The estimates of gross returns and profits also showed some changes in favour of biofertilizer users depicting a bit higher B:C ratio.

5.11 Production Function Analysis For Biofertilizer Used and Non-Used Crops

The previous analysis is mostly relied on the sample means and proportions of individual items in the total of respective variates. This type of analysis deployed for the purpose, however, has certain limitations of its own as it could not measure the relative contributions of individual resources in combination of other resources in influencing input and output levels of crops.

This part of chapter is devoted to discuss the resource use productivities of the biofertilizer used and non-used crops. The resource productivities in crop production have been estimated within the Cobb-Douglas type of production function frame work. The Cobb-Douglas production function which is linear in logarithm has got certain well-known advantages over simple regression function. It gives directly elasticity of production with respect to the factors of production. The individual elasticity shows approximately the average percentage change in total product which might be forthcoming if the given factor increases by one per cent and the

others held constant. The details regarding specification of the model and measurement of variables have already been given in the chapter on methodology. The eight and seven variables were selected for estimating production function of biofertilizer used and non-used crops, respectively.

Different statistical tests of significance were used to judge the efficiency of individual regression coefficients and coefficients of multiple correlation in respect of all the production functions. The coefficient of multiple determination (R^2) indicates the proportion of total variation in the dependent variable explained jointly by the independent variables. At the same time, the regression coefficients of individual resource variables are the production elasticity of respective resources, which indicates the percentage change in crop output associated with one percentage change in the concerned input at their geometric mean level. On the whole, these results are of paramount importance as they provide readily the information relative to probable effects of resource use changes on crop output.

5.11.1 Resource productivity in biofertilizer user and non-user farms

The crop wise estimated parameters of the production functions of the biofertilizer user and non-user farms are presented in Table 5.11

Table 5.11 Results of estimated Cobb-Douglas production functions for selected crops on the farms of biofertilizer users and non-users

Particulars	Wheat		Gram		Groundnut		Soybean		Sugarcane	
	User N = 37	Non-user N = 34	User N = 16	Non-user N = 14	User N = 23	Non-user N = 27	User N = 17	Non-user N = 19	User N = 31	Non user N = 37
Constant (a)	6.386 ^{***}	1.116	1.827	0.541	9.083	1.374	1.465	0.069	3.844 ^{***}	1.420
Human labour (Mandays) (X ₁)	1.161 ^{***} (0.413)	0.967 [*] (0.381)	0.228 [*] (0.115)	0.006 (0.553)	0.057 (0.540)	0.448 ^{**} (0.215)	0.305 (0.802)	0.225 (0.148)	0.054 ^{***} (0.018)	0.073 (0.158)
Bullock labour (pair days) (X ₂)	0.130 (0.119)	0.172 (0.155)	0.004 (0.228)	0.062 [*] (0.030)	0.003 (0.178)	0.178 ^{**} (0.097)	0.007 (0.195)	0.015 (0.124)	0.039 (0.295)	0.012 (0.121)
Manure in quintals (X ₃)	0.066 (0.078)	0.200 ^{***} (0.063)	0.074 (0.336)	0.131 (0.136)	0.282 [*] (0.137)	0.081 ^{**} (0.033)	0.024 ^{**} (0.008)	0.164 (0.185)	0.262 (0.512)	0.084 ^{***} (0.024)
N (X ₄) in kilograms	0.054 (0.054)	0.057 (0.075)	0.088 (0.142)	0.029 (0.058)	0.086 [*] (0.048)	0.010 (0.054)	0.119 [*] (0.057)	0.060 ^{**} (0.023)	0.144 [*] (0.079)	0.131 ^{***} (0.047)
P (X ₅) in kilograms	0.084 [*] (0.042)	0.038 (0.066)	0.134 [*] (0.065)	0.025 [*] (0.012)	0.191 ^{***} (0.047)	0.005 (0.028)	0.047 (0.133)	0.069 ^{**} (0.027)	0.134 (0.100)	0.087 (0.191)
K (X ₆) in kilograms	0.010 (0.014)	0.065 (0.122)	0.030 (0.029)	0.166 [*] (0.091)	0.019 (0.023)	0.030 (0.031)	0.026 (0.027)	0.032 (0.089)	0.031 [*] (0.018)	0.186 (0.183)
Other working capital (X ₇) in Rs.	0.354 (0.232)	0.305 ^{***} (0.094)	0.063 [*] (0.026)	0.233 (0.441)	2.932 ^{***} (0.929)	0.373 (0.256)	0.402 [*] (0.196)	0.111 ^{***} (0.032)	0.005 (0.728)	0.285 (0.222)
Biofertilizer (X ₈) in gms	0.140 [*] (0.072)	-	0.158 [*] (0.068)	-	0.087 ^{**} (0.039)	-	0.160 (0.252)	-	0.098 ^{***} (0.033)	-
R ²	0.50	0.51	0.54	0.58	0.63	0.71	0.62	0.75	0.72	0.51
F value	4.11 ^{**}	4.68 ^{**}	2.95 ^{**}	2.49 ^{**}	3.64 ^{**}	4.06 ^{**}	2.08 ^{**}	6.00 ^{**}	8.37 ^{**}	5.20 ^{**}

^{*}, ^{**} and ^{***} indicates 10, 5 and 1 per cent significant level

Figures in parentheses indicate the standard errors of respective coefficients

5.11.1.1. Wheat

In case of biofertilizer users, the regression coefficients of human labour, biofertilizer and phosphorus were found to be positive and significant, indicating the positive influence on the output of the wheat. If the human labour, biofertilizers and phosphorus are increased by one per cent, *ceteris paribus*, the output of wheat would increase by 1.16, 0.14 and 0.08 per cent, respectively. However, in case of non-users, human labour, manures and other working capital were found to be positive and significant. If human labour, manure and other working capital are increased by one per cent, *ceteris paribus*, the output of wheat would increase by 0.96, 0.20 and 0.30 per cent, respectively. The F ratio was observed to be positive and significant which indicated the goodness of the fit of the equation.

5.11.1.2. Gram

In biofertilizer users, the value of coefficient of multiple determination (R^2) was 0.54, indicating that 54 per cent of variation in the output is jointly explained by the factors under consideration. In the production of gram, the regression coefficients representing human labour, biofertilizers, phosphorus and other working capital observed to be positive and significant at 10 per cent level. These values indicated that there is a scope for increasing the gram production by using more of these factors. However, in biofertilizer non-users, the value of coefficient of multiple determination was

0.58, indicating that 58 per cent variation in output is jointly explained by the factors under consideration. The coefficients of bullock labour, phosphorus and potash are noted to be positive and significant at 10 per cent level indicating that these are the important variables for which the production of gram is responsive.

5.11.1.3. Groundnut

The results have shown that nearly 63 per cent variation in groundnut production is explained jointly by the eight variables under consideration. The regression coefficients of manure, biofertilizer, nitrogen, phosphorus and other working capital have observed to be positive and significant indicating that there is a scope for increasing the output of groundnut. In case of non-users, the results indicated that nearly 71 per cent of variation in groundnut production is explained by the seven independent variables under consideration. The regression coefficients of human labour, bullock labour and manure are observed to be positive and significant at 5 per cent level. The significant value of F-statistics indicates the goodness of fit of the model used.

5.11.1.4. Soybean

The value of coefficient of multiple determination (R^2) is observed to be 0.62. Importantly, three variables viz., manure, nitrogen and other working capital have turned out to be positive and significant. The F-ratio is found significant. In case of non-users the selected seven independent variables have jointly

explained 75 per cent of total variation in the dependent variable. The coefficients of nitrogen, phosphorus and other working capital are noted to be positive and significant.

5.11.1.5 Sugarcane

About 72 per cent of variation in the production of this crop is jointly explained by the eight variables under consideration. However, if individual coefficient is examined for its significance, only four variables viz. human labour, biofertilizers, nitrogen and potash have turnout to be positive and significant. In case of biofertilizer non-users the seven independent variables have jointly explained 51 per cent of total variation in the dependent variable. If manures and nitrogen are increased by one per cent, *ceteris paribus*, there would be an increase in yield by 0.08 and 0.13 per cent, respectively. The estimated F ratio was also found significant.

To sum up, it can be said that the selected independent variables for the individual crops viz., wheat, gram, groundnut, soybean and sugarcane have jointly explained the variation in the range of 50 to 72 per cent of the total variation in their output. The regression coefficients of human labour (X_1) in case of wheat and sugarcane, biofertilizers (X_8) in sugarcane, phosphorus (X_5) and other working capital (X_7) for groundnut were found to be positive and highly significant at 1 per cent level. Indicating the influence of these variables on productivity of these crops. However, in case of biofertilizer non-users, the coefficient of multiple determination (R^2)

for the above said crops ranged between 0.51 to 0.71. The coefficients of manures (X_3) for wheat and sugarcane, nitrogen (X_4) for sugarcane and other working capital (X_7) for wheat and soybean were positive and highly significant at 1 per cent level indicating the positive influence of these variables on the productivity of the above said crops.

5.11.2 Statistical test for comparing production relations on biofertilizer used and non-used crops

The pooled analysis of the entire sample farms was carried out with a view to apply 'Chow's test' of equality. In other words, the significance of difference between the crop production functions of biofertilizer used and non-used crops was tested by using 'Chow's test'.

It is observed from Table 5.12 that the F ratios were 5.25, 7.11, 3.19, 3.00 and 3.74 in case of wheat, gram, groundnut, soybean and sugarcane, respectively which were significant, indicating that the two regressions were not equal but differed significantly in their overall production relationships.

The calculated ' F ' is greater than table ' F ' which indicates that the two regressions differed from each other either in intercepts or slopes or both.

Table 5.12 Statistical test for comparing production relations on biofertilizer used and non-used crops

Sr. No	Crop	No. of parameters (K)	Degree of freedom ($K_1N_1 + N_2 - 2K$)	S_4 ($S_2 + S_3$)	S_5 ($S_1 - S_4$)	F Value
1.	Wheat	8	55	182.00	138.61	5.25
2.	Gram	8	18	36.68	115.67	7.11
3.	Groundnut	8	23	38.77	42.91	3.19
4.	Soybean	8	19	33.04	41.54	3.00
5.	Sugarcane	8	52	1216951.40	701283.60	3.74

5.12 Constraints in biofertilizer use

Though the benefits derived from the use of biofertilizers are quite significant, they have not become popular due to various constraints at production, distribution, field and marketing levels.

These constraints can be classified as :

- 5.12.1 Production constraints
- 5.12.2 Marketing constraints
- 5.12.3 Resource constraints
- 5.12.4 Field level constraints

5.12.1. Production constraints

The progress in the field of biofertilizer production is below satisfaction due to following constraints

- i) Unavailability of appropriate and efficient strains as biofertilizers are not only crop specific but also soil specific too.
- ii) Unavailability of suitable carrier due to which self life of biofertilizers is short.
- iii) Biofertilizers tend to mutate during fermentation. Presently, there are no effective measures to eliminate mutation.

5.12.2. Marketing constraints

The consumption has not picked up to the desired level due to various marketing and market related constraints as given below :

- i) Lack of awareness among farmers
- ii) Because of inadequate and inexperienced marketing staff, acceptance of biofertilizers has been very limited in the rural areas.
- iii) The sale of poor quality biofertilizers through corrupt marketing practices results to loss of faith.
- iv) Biofertilizer has seasonal demand.

5.12.3. Resource constraints

The following are the resource constraints in production of biofertilizers on commercial scale.

- i) The resource generation particularly from private sector is very limited because of short self life and no guarantee of take off of biofertilizers.
- ii) The crop response to biofertilizer is inconsistent, so poor farmer do not take the risk of using biofertilizers.

5.12.4. Field level constraints

Besides various production, marketing and resource constraints, there are a large number of field level constraints as indicated below :

- i) Poor crop management and use of poor agricultural practices make biofertilizers ineffective.
- ii) Majority of farmers do not know proper inoculation techniques of biofertilizers.
- iii) The reason for inadequate popularity of biofertilizers is that biofertilizers can not show instant and dramatic response like chemical fertilizers.
- iv) Lack of strong promotion and extension work and insufficient publicity.
- v) Lack of availability of the quality products in time in rural area.

The sample farmers were exposed for open ending questions pertaining to the problems faced by the adaptors of biofertilizers. They have expressed their views and these views are tabulated in percentage and averages which are depicted in Table 5.13 along with the graphical presentation as indicated in Fig.20

It is revealed from the table that, 35.00 per cent of biofertilizer users have reported the high cost of liquid biofertilizers as an economic problem. The lack of availability in time as the problem was pointed out by 26.66 per cent of the biofertilizer users. The problem of lack of technical know-how was raised by 24.99 per cent of the total biofertilizer users.

Table 5. 13 Constraints in the use of biofertilizers

Sr. No.	Nature of problem	Biofertilizer users N = 60	Percentage
1	Lack of availability in time	16	26.66
2	Lack of technical know how	15	24.99
3	Inadequate popularity	8	13.33
4	Not showing instant response like chemical fertilizers	10	16.66
5	Lack of strong extension work	7	11.67
6	Lack of awareness	2	3.34
7	High cost of liquid biofertilizers	21	35.00
8	No constraints	4	6.65

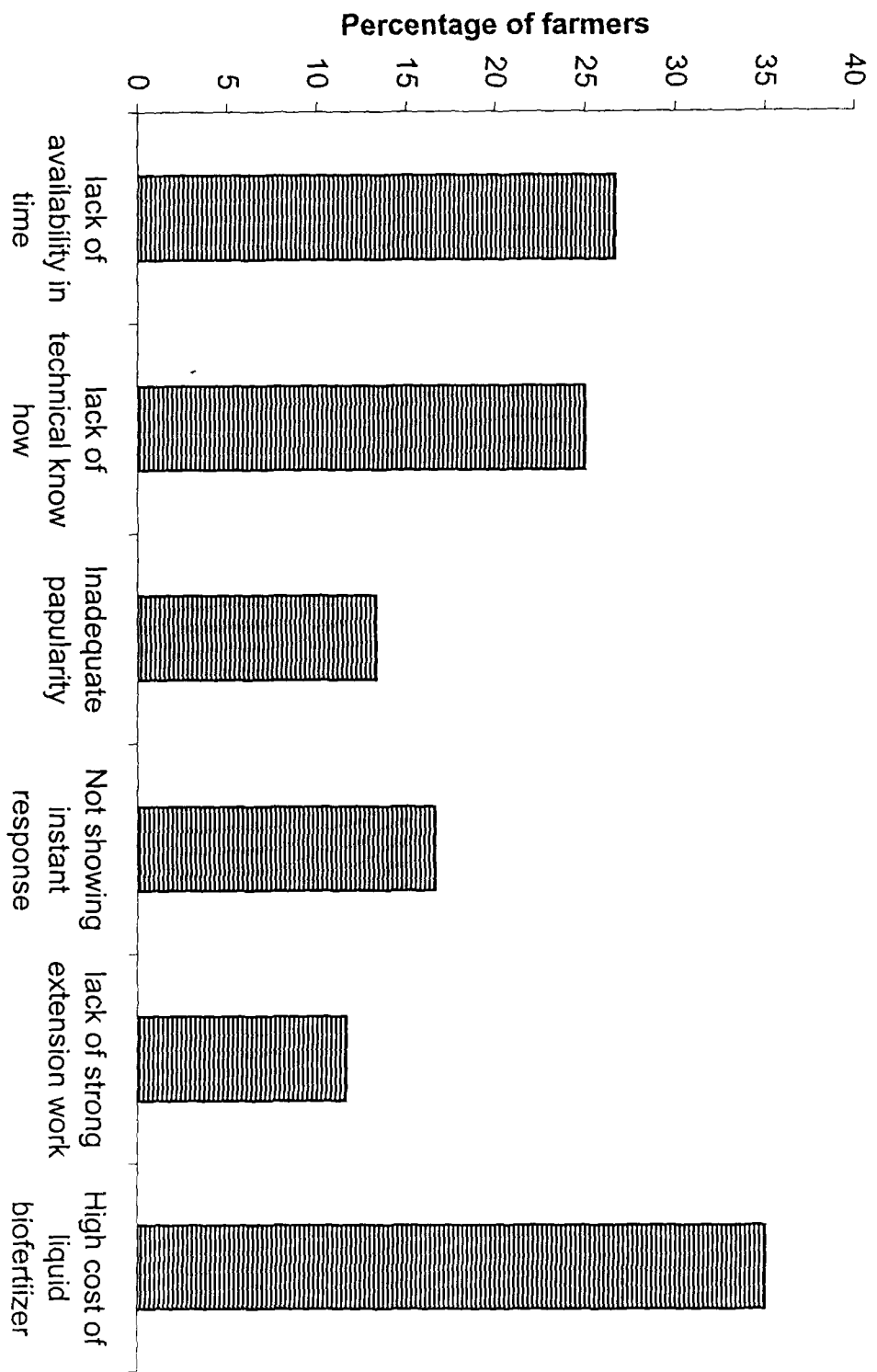


Fig. 20 : Constraints in use of biofertilizers

The problem of not showing instant response of crops like chemical fertilizers was reported by 16.66 per cent of the sample cultivators. Inadequate popularity was also the problem of 13.33 per cent of the sample cultivators.

The lack of strong extension work and lack of awareness were some of the other problems indicated by 11.67 and 3.34 per cent of the total biofertilizer users, respectively. The 6.65 per cent of the biofertilizer users had no any constraints.

To sum up, it can be said that high cost of liquid biofertilizer was the major constraint for most of the biofertilizer users. Constraints such as lack of availability in time and lack of technical know-how were also of considerable importance to the biofertilizer users.

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*SUMMARY AND
CONCLUSIONS*

6. SUMMARY AND CONCLUSIONS

6.1 General

Experience has shown that high yielding crop varieties require more chemical fertilizers for improving the productivity which results into increasing the cost of production. The judicious combination strategy evolved by using biofertilizers as supplement to chemical fertilizers for maximization of yield and minimizing cost of production, deserves a lot of significance in the new economic order of W. T. O. regime. It looks from the literature that the scientific studies on economic assessment of biofertilizer use on farm economy are scarce. There is a need for scientific assessment of the impact of the biofertilizers on farm productivity and returns on farms. The nature and extent of biofertilizer use need to be examined to understand the mode and pattern of its use. Biofertilizers are being viewed as a useful input to reduce the use of chemical fertilizers and thereby to reduce the cost of cultivation of crops. Accordingly, several attempts are made to popularize the use of biofertilizers amongst the cultivators. In view of this, it becomes necessary to study the constraints in the use of biofertilizers at the farm level. It is in this context the present study viz., impact of biofertilizer use on crop productivity in Ahmednagar district has been taken up with the following specific objectives.

Objectives

1. To examine the nature and extent of biofertilizer use on sample farms
2. To assess the effects of biofertilizer use on productivity of crops.
3. To estimate the resource use levels, costs and returns of biofertilizer user and non- user crops.
4. To estimate the resource use productivities of major inputs of biofertilizer user and non- user crops.
5. To study the constraints in use of biofertilizers.

It was proposed to choose five villages from Rahuri tahsil in Ahmednagar district of Western Maharashtra for the study. The list of bio-fertilizer users and non-users from each of selected villages was prepared on the basis of information available with ATIC, MPKV., Rahuri, Taluka Panchayat Samiti, Rahuri and Agro-Services Centre, Rahuri. The biofertilizer users and non-users in selected village were arranged in ascending order of their operational holdings and 12 farmers each for users and non-users category were drawn through systematic random sample technique. Thus, the total sample for the study consists of 120 farmers comprising 60 biofertilizer users and 60 biofertilizer non-users spread over 5 villages of Rahuri tahsil of Ahmednagar district.

Data from the sample biofertilizer users and non-users were collected by survey method with the help of a specially

designed schedule for the purpose. The information on kind and magnitude of biofertilizers used for crops, productivity, resource use levels, costs and returns structure of crops on user and non-user farms and constraints in the use of biofertilizers was collected from sample cultivators by survey method for the year 2002-03.

Primarily, tabular method of analysis was used for studying nature and extent of biofertilizer use, effects of biofertilizer use on crop productivity and constraints in the use of biofertilizers by sample farms. The effect of biofertilizers on crop productivity was examined by comparing productivity of selected crops on farms of users and non-users. The simple statistical tools such as averages, percentages and proportions were used to highlight the results of the study. The cost of cultivation of the major crops on biofertilizer used farms and non-used farms was estimated by standard cost concepts (cost A, B, C, returns at Cost A, B, C and B:C ratio) usually used in farm cost studies.

A Cobb-Douglas type of production function was fitted for estimating the resource use productivities on sample farms of biofertilizer used and non-used crops. The variables included in the production function analysis were per hectare yield (quintals) as the dependent variable and per hectare use of human labour (mandays), bullock labour (pair days), manure (qtls), nitrogen (kg), phosphorus (kg), potash (kg), other working capital (Rs.) and biofertilizers (gms) as the independent variables. The 'Chow's test' of equality has been applied to know whether the production

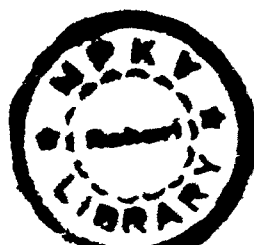
relations among these two categories for selected crops differ or otherwise. This became useful to assess the impact of biofertilizer use on the overall production relations of these two categories of farms

6.2 Summary of Findings

The data on nature and extent of biofertilizers use for various crops, effects of biofertilizer on crop productivity, resource use levels, costs and returns, resource use productivity and constraints in the use of biofertilizers were obtained from the sample users and non-users for the year 2002-03. These data were analysed in accordance with the objectives and the results obtained are briefly outlined as under.

The average size of the sample farm families was 4.24 persons at the overall level. The proportion of males and females was a bit more in case of biofertilizer non-users and the proportion of children was more in case of biofertilizer users. The proportion of male and female earners was more in biofertilizer users than the non-users. The percentage of illiteracy was more in case of biofertilizer non-users than the users.

The proportionate share of residence and cattle byre in the total value of capital assets was maximum in case of biofertilizer users. The percentage of cropping intensity was maximum in case of biofertilizer non-users (151.46 per cent) while it was minimum in case of biofertilizer users (117.85 per cent). The average irrigated area in case of users was 1.18 ha., which



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accounted for 45.49 per cent of the average size of holding. Similarly in case of non-users, it was 0.75 ha. which accounted for 51.34 per cent of the average size of holding. It is thus noted that the proportion of irrigated area was more by 5.85 per cent in case of biofertilizer non-user farms than user farms. The proportionate area under food grains, vegetables and fruit crops was maximum in biofertilizer user farms while that of sugarcane and oilseed crops was maximum on the farms of biofertilizer non-users.

The sample farmers in kharif season used *Rhizobium* for production of soybean (26.65 per cent) followed by groundnut (23.34 per cent) and tur (16.66 per cent). The per hectare use of biofertilizers was more than the recommended level in the case of bajra and soybean. The per hectare use of liquid biofertilizers was a bit low than the recommended level, especially in the case of tur and groundnut. It is also noted that, by and large, the use of biofertilizers may be in powder or liquid form, has not been popularized since the per cent of users of sample farms for individual crops was very low in the area under study.

The percent of users of biofertilizers for rabi crops was observed to be low in the area under study. It is also noted that by and large per hectare use of biofertilizers for rabi crops was less than the recommended level by 13 to 50 per cent and use of liquid biofertilizer was more than the recommended level by 66.67 per cent. It is seen that 58.33 per cent of sample farms used *Azotobacter* for

wheat crop while only 1.67 per cent of farms used *Azospirillum* for tomato crop.

The per hectare use of *Azotobacter* and P.S.B. was less than the recommended level in case of sugarcane. Where as, the per hectare use of *Chargex* for chilli and brinjal and *Agrostrong* for sugarcane was more than the recommended level. Interestingly, the use of *Azospirillum* for brinjal was equal to the recommended level. The most striking point noted is that the percent of users of biofertilizers for commercial crops such as chilli, brinjal and sugarcane ranged between 3.34 per cent and 28.34 per cent of sample farms in the area under study. This has indicated the poor spread of biofertilizers for crop production in the area under study

The per hectare difference in productivity of onion crop was more by 25.89 quintals on the farms of biofertilizer users than the non- users. Such difference in productivity due to use of biofertilizers was 8.22 qtls in bajra, 6.56 qtls in soybean, 3.53 qtls in tur and 3.48 qtls in groundnut. As regards percentage increase in productivity, it was 40.77, 31.12, 21.69, 19.00 and 11.72 per cent in the case of soybean, bajra, tur, groundnut and onion crops, respectively. This has clearly shown the positive impact of biofertilizer use on the productivity of kharif crops

The per hectare difference in productivity of sugarcane crop was more by 303.42 quintals on the farms of biofertilizer users than the non-users. Such difference in productivity due to use of biofertilizers was 8.34 qtls in chilli, 2.50 qtls in tomato, 2.06 qtls in

gram, 1.69 qtls in wheat and 1.50 qtls in brinjal. As regards percentage increase in productivity, it was 31.30, 16.43, 15.63, 6.77, 1.21 and 1.13 per cent in the case of sugarcane, brinjal, chilli, wheat, gram and tomato crops, respectively. This has clearly shown the positive impact of biofertilizer use on the productivity of rabi crops in the area under study.

The per hectare yield of bajra, tur and sugarcane was more than the recommended level, even though the use of manures and fertilizers was less than the recommended levels, in case of biofertilizer user farms. The actual use of manures was less than recommended level in all biofertilizer non-user crops. Percentage gap of manure, nitrogen, phosphorus and potash was higher in soybean, groundnut, brinjal and tomato, respectively. The actual yield received by biofertilizer non-user farms is observed to be less than recommended level due to low use of manures and fertilizers.

During kharif season, percentage change in output was maximum in soybean crop and minimum in onion crop. The percentage change in profit at cost C was maximum in bajra crop and minimum in onion crop. The biofertilizer users could get higher yields in production of rabi crops and therefore higher returns as compared to non-users. This has been indicated by the higher B:C ratios in selected rabi crops on the farms of biofertilizer users as compared to their counterparts. The use of biofertilizers for brinjal and sugarcane enabled the users to have a bit higher productivity in brinjal and relatively larger productivity in sugarcane. The

estimates of gross returns and profits also showed some changes in favour of biofertilizer users depicting a bit higher B:C ratio.

The selected eight independent variables for the individual crops viz., wheat, gram, groundnut, soybean and sugarcane have jointly explained the variation in the range of 50 to 72 per cent of the total variation in their output. The regression coefficients of human labour (X_1) in case of wheat and sugarcane, biofertilizers (X_8) in sugarcane, phosphorus (X_5) and other working capital (X_7) for groundnut were found to be positive and highly significant at 1 per cent level indicating the positive influence of these variables on productivity of these crops. However, in case of non-users, the coefficient of multiple determination (R^2) for the above said crops ranged between 0.51 to 0.71. The coefficients of manures (X_3) for wheat and sugarcane, nitrogen (X_4) for sugarcane and other working capital (X_7) for wheat and soybean were positive and highly significant at 1 per cent level. The application of 'Chow's test indicated that the two regressions differed from each other either in intercepts or slopes or both.

The high cost of liquid biofertilizer was the major constraint for most of the biofertilizer users. Constraints such as lack of availability of biofertilizers in time and lack of technical know-how were also of considerable importance to the biofertilizer users.

6.3 Conclusions

Following conclusions could be drawn from the above said findings of the study

1. The study specifically concluded that during kharif season, the per hectare use of *Azotobacter*, *Azospirillum* and PSB for Bajra *Rhizobium* for tur and soybean, PSB for soybean and groundnut was more than recommendation, while the per hectare use of *Chargex* for tur and groundnut and *Azospirillum* for onion was less than recommendation.
2. During rabi season, per hectare use of *Chargex* for chilli and brinjal was more than recommendation, while use of *Azospirillum* for brinjal was similar to recommendation.
3. During summer season, per hectare use of *Chargex* for chilli and brinjal was more than recommendation, while use of *Azospirillum* for brinjal was similar to recommendation.
4. In case of sugarcane, per hectare use of *Azotobacter* and PSB was less than recommendation, while per hectare use of liquid biofertilizer was more than recommendation.
5. The use of biofertilizers lead to increase in crop productivity. The per hectare productivity has been increased by 40.77, 31.30, 31.12, 21.69, 19.00 and 15.63 per cent in case of soybean, sugarcane, bajra, tur, groundnut and chilli, respectively. As a results, the B:C ratio, by and large, is observed to be a bit more in biofertilizer used crops than the non-used crops.
6. On the basis of regression analysis it could be concluded that use of biofertilizer has significant impact on the yield of sugarcane, groundnut, gram and wheat, in the area under study.

7. It is clearly seen that the per cent of users of biofertilizers for the selected crops was observed to be low indicating their poor spread among the cultivators in the area under study.
8. The high cost of liquid biofertilizers was a major constraints in the use of biofertilizers at the farm level. There are also some constraints such as lack of availability of biofertilizers in time and lack of technical know-how about their use were also observed at farm level.

6.4 Policy Implications :

On the basis of findings of investigation, the following policy implications are emerged

1. Use of biofertilizers at the farm level was either more or less than their recommendation for individual crops. Besides, the use of biofertilizers has not been popularized among the farmers. In view of this , there is a need to guide the cultivators about the use of biofertilizers by the extension agency in the rural area of the state.
2. The constraints such as high cost of liquid biofertilizers, lack of availability of biofertilizers in time and lack of technical know-how about their use need to be suitably removed in order to popularize its use for agriculture production.

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APPENDICES

8. APPENDICES

APPENDIX - I

Schedule for Impact of Biofertilizer use on crop productivity in Ahmednagar District

Biofertilizers users/non-users

I. Name of the Farmer :

i) Village ii) Taluka iii) Age iv) Education
v) District

II. Information about Family Members

Sr. No	Name of the family members	M/F	Age (yrs)	Education	Occupation	Annual income
1						
2						
3						
4						
5						

III. Information about Land

Gat No.	Soil type	Area (ha)				Present value of land (Rs.)		Land Revenue (Rs.)
		Total	Irri	Dry	Fallow	Irrig.	Dry	

V. Information on Capital Assets

1. Buildings

Sr. No	Category	Type of construction	Year of construction	Present value (Rs.)	Repairs	Remaining life
1.	Residence					
2.	Farm house					
3.	Cattle byre					
4.	Other structure i) ii)					

2. Well and irrigation structure

Sr. No	Category	Year of construction	Share in (%)	Present value (Rs.)	Repairs (Rs)	Remaining life
1	Well					
2	Bore well					
3	Oil engine					
4	Electric motor					
5	Pipeline					
6	Drip/sprinkler					

3. Livestock inventory

Sr. No	Type	No	Breed	Year of purchase	Age	Present value	Remarks
1.	Bullocks						
2.	Cows i) Milch ii) Dry						
3.	Buffaloes i) Milch ii) Dry						
4.	Goat						
5.	Sheep						
6.	Poultry						
7.	Other						

4. Farm implements and machinery

Sr. No	Item	No.	Year of purchase	Present value (Rs.)	Repairs (Rs.)	Remarks
1	Iron plough					
2	Wooden plough					
3	Seed drill					
4	Harrow					
5	Bullock cart					
6	Tractor					
7	Duster					
8	Sprayer					
9	Thresher					
10	Crusher					
11	Kudali					
12	Spade					
13	Sickle					
14	Ghamele					
15	Basket					
16	Iron basket					
17	Rope					
18	Cycle					
19	Motor cycle					

VII) Cost of Cultivation

1. Name of crop : 2. Season : 3. Area (ha) : 4. Variety :
5. Irri/Unirri : 6. Source of Irrigation : Well/Tube well/canal/lift 7. Method of biofertilizer use

Operations	No.	Material used		Labour Required (Hours)								
				Owned				Hired				
		Name	Qty	Value (Rs.)	Male	Female	Bullock	Machine	Male	Female	Bullock	Machine
Ploughing												
Clod crushing, Cleaning etc												
Manuring												
Harrowing												
Sowing/transplanting												
Fertilizer application (Chemical fertilizer)												
Biofertilizer												
Weeding/earthing up												
Hoeing etc												
Irrigation												
Plant protection												
Watching etc.												
Harvesting/Transporting												
Threshing/winnowing												
Other operations												
Main produce : Qty (Qtls/Tons)				Value (Rs.) :	By-produce : Qty (Qtls/Tons)				Value (Rs.) :			

VIII. Constraints in the Use of Biofertilizers

Nature of problem

1. Lack of availability in time
2. Lack of technical know-how
3. Inadequate popularity
4. Not show instant response like chemical fertilizers
5. Lack of strong extension work
6. Lack of awareness
7. High cost of liquid biofertilizers
8. No constraints

APPENDIX - II

Per hectare Cost of Cultivation of Soybean crops on sample farms

Cost items	Soybean			
	Biofertilizer user		Biofertilizer non-user	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	10.34	517.22	9.83	491.85
Female	53.35	2134.18	46.95	1878.26
Bullok power (pairdays)	6.33	948.98	4.62	692.93
Machine Power(hrs)	26.22	3146.94	23.26	2791.30
Seed (kg)	75.2	1504.08	77.17	1543.48
Manure (qtls)	3.57	178.57	4.78	239.13
Biofertilizer (gm)	510.2	28.37	0	0
Chemical Fertilizer (Kg)				
N	46.12		38.97	
P	46.53		45.6	
K	16.99		7.23	
Value		1677.86		1399.57
Irrigation charges		595.71		584.20
Pl. prtecton charges		132.14		41.85
Incidetial charges& Repairs		301.94		360.00
Working Capital (1 to 9)		11165.99		10022.61
Interest on working capital		781.62		701.58
Depreciation on farm impl.		820.51		675.33
Land revenue		37.35		32.39
Cost A		12805.47		11431.91
Rental value of land		5400.20		4046.87
Interest on fixed capital		1726.22		1410.43
Cost B		19931.9		16889.21
Family labour days				
Male	5.88	294.01	6.2	310.46
Female	12.42	496.94	11.57	463.04
Cost C		20722.84		17662.71
Output				
Main produce(qtls)	22.65	32469.39	16.09	24342.39
By-produce (qtls)	6.12	155.92	5.33	133.15
Total value		32625.31		24475.54
Cost C net of by-produce		20566.93		17529.56
Per quintle cost		907.90		1089.67

Per hectare Cost of Cultivation of Tur crops on sample farms

Cost items	Tur			
	Biofertilizer use		Biofertilizer non-use	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	4.7	235.02	5.63	281.82
Female	20.88	835.27	23.5	940.00
Bullok power (pairdays)	9.9	1485.02	7.55	1131.82
Machine Power(hrs)	16.22	1946.76	16.73	2007.27
Seed (kg)	19.97	499.17	20.73	518.18
Manure (qtls)	14.81	740.43	19.09	945.55
Biofertilizer (gm)	266.22	44.93	0	0
Chemical Fertilizer (Kg)				
N	36.94		44.27	
P	45.76		56.82	
K	17.72		15.91	
Value		1443.26		1645.27
Irrigation charges		829.62		854.18
Pl. prtction charges		172.21		130
Incidetial charges& Repairs		213.14		221.09
Working Capital (1 to 9)		8444.84		8685.45
Interest on working capital		886.71		911.97
Depreciation on farm impl.		1045.42		1007.5
Land revenue		29.28		29.27
Cost A		10406.26		10634.15
Rental value of land		5053.91		4081.33
Interest on fixed capital		1725.12		1579.64
Cost B		17185.29		16295.1
amilyl labour days				
Male	2.66	133.11	3.09	154.55
Female	6.46	258.74	7.81	312.73
Cost C		17577.14		16762.40
Output				
Main produce(qtls)	19.8	30499.17	16.27	24663.64
By-produce (qtls)				
Total value		30499.17		24663.64
Cost C net of by-produce		17577.14		16762.40
Per quintle cost		887.71		1030.09

Per hectare Cost of Cultivation of Bajra crops on sample farms

Cost items	Bajra			
	Biofertilizer use		Biofertilizer	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	4.84	242.31	6.11	305.71
Female	70.75	2830.00	61.76	2470.65
Bullok power (pairdays)	18.62	2792.31	7.55	1133.15
Machine Power(hrs)	16.15	1938.46	28.38	2445.65
Seed (kg)	3.19	485.23	3.89	587.72
Manure (qtls)	26.31	1315.38	21.85	1092.39
Biofertilizer (gm)	361.54	21.85	0	0
Chemical Fertilizer (Kg)				
N	33.92		23.83	
P	22.38		21.55	
K	6.92		6.55	
Value		983.23		774.46
Irrigation charges		702		572.61
Pl. prtction charges				
Incidential charges& Repairs		430.31		472.39
Working Capital (1 to 9)		11741.08		9282.12
Interest on working capital		821.88		649.75
Depreciation on farm impl.		623.38		469.02
Land revenue		30.31		28.8
Cost A		13216.64		11042.39
Rental value of land		3873.92		2750.91
Interest on fixed capital		1498.46		835.11
Cost B		18589		14628.4
Family labour days				
Male	6.59	329.81	5.85	261.55
Female	9.57	383.08	8.07	322.83
Cost C		19301.91		15175.27
Output				
Main produce(qtls)	34.31	21099.23	26.09	15501.09
By-produce (qtls)	25.85	2326.15	13.8	1242.39
Total value		23425.38		16743.48
Cost C net of by-produce		16975.76		13320.19
Per quintle cost		494.80		534.09

Per hectare Cost of Cultivation of Groundnut crops on sample farms

Cost items	Groundnut			
	Biofertilizer use		Biofertilizer non-use	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	3.08	154.38	3.32	166.40
Female	70.25	2810.26	60.64	2425.97
Bullok power (pairdays)	7.74	1160.26	5.65	847.40
Machine Power(hrs)	12.65	1517.95	14.03	1683.12
Seed (kg)	98.97	4453.85	102.60	4704.55
Manure (qtls)	22.91	1145.3	15.71	785.71
Biofertilizer (gm)	961.54	195.21	0	0
Chemical Fertilizer (Kg)				
N	35.66		47.31	
P	45.11		41.66	
K	13.82		12.11	
Value		1445.04		1530.39
Irrigation charges		1101.2		1062.08
Pl. prtction charges		296.58		100
Incidetial charges& Repairs		432.65		406.75
Working Capital (1 to 9)		14712.67		13712.37
Interest on working capital		1029.89		959.87
Depreciation on farm impl.		769.57		680
Land revenue		33.59		31.43
Cost A		16545.72		15383.66
Rental value of land		5311.85		4415.87
Interest on fixed capital		1343.85		1073.12
Cost B		23201.42		20872.65
Family labour days				
Male	7.76	388.35	7.43	371.75
Female	38.48	1539.32	35.68	1427.27
Cost C		25129.09		22671.67
Output				
Main produce(qtls)	21.79	31474.36	18.31	26068.18
By-produce (qtls)	7.48	598.29	7.53	615.58
Total value		32072.65		26683.77
Cost C net of by-produce		24530.80		22056.09
Per quintle cost		1125.53		1204.48

Per hectare Cost of Cultivation of Onion crops on sample farms

Cost items	Onion			
	Biofertilizer use		Biofertilizer non-use	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	15.27	763.54	16.13	806.64
Female	233.91	9356.67	234.35	9370.31
Bullok power (pairdays)	12.67	1900.00	8.83	1324.22
Machine Power(hrs)	27.17	3260.00	25.78	3093.75
Seed (kg)	10.17	3135.00	10.08	3023.44
Manure (qtls)	35	1750	33.59	1679.69
Biofertilizer (gm)	833.33	136.83	0	0
Chemical Fertilizer (Kg)				
N	77.71		68.59	
P	47.54		54.17	
K	28.21		25.55	
Value		2121.17		1989.69
Irrigation charges		1405		1414.06
Pl. prtction charges		606.67		549.53
Incidetial charges& Repairs		389.17		422.50
Working Capital (1 to 9)		24824.04		23673.83
Interest on working capital		1737.68		1657.17
Depreciation on farm impl.		750.17		637.81
Land revenue		33.17		33.75
Cost A		27345.06		26002.56
Rental value of land		18798.78		18145.94
Interest on fixed capital		1524.5		1401.09
Cost B		47668.34		45549.59
Family labour days				
Male	12.68	634.38	11.83	591.8
Female	33.93	1357.50	40.27	1610.94
Cost C		49660.21		48752.32
Output				
Main produce(qtls)	246.67	112991.67	220.78	109078.13
By-produce (qtls)				
Total value		112991.67		109078.13
Cost C net of by-produce		49660.21		47752.32
Per quintle cost		201.32		216.28

Per hectare Cost of Cultivation of Wheat crops on sample farms

Cost items	Wheat			
	Biofertilizer use		Biofertilizer non-use	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	7.42	371.11	9.33	466.95
Female	49.44	1977.62	44.83	1793.42
Bullok power (pairdays)	8.99	1349.10	7.76	1163.79
Machine Power(hrs)	13.3	1595.91	10.63	1275.86
Seed (kg)	103.58	1428.64	101.53	1356.00
Manure (qtls)	13.64	682.01	16.16	807.79
Biofertilizer (gm)	1236.15	73.91	0	0
Chemical Fertilizer (Kg)				
N	59.63		47.96	
P	37.49		35.44	
K	10.59		12.8	
Value		1503.84		1349.23
Irrigation charges		1306.91		1346.62
Pl. prtction charges		332.05		317.69
Incidetial charges& Repairs		436.66		341.38
Working Capital (1 to 9)		11059.05		10218.74
Interest on working capital		774.13		715.31
Depreciation on farm impl.		620.84		944.57
Land revenue		28.09		26.44
Cost A		12482.11		11905.06
Rental value of land		3557.73		3440.12
Interest on fixed capital		2321.1		2251.85
Cost B		18360.94		17597.04
Family labour days				
Male	9.67	483.54	21.43	1071.6
Female	15.33	613.38	11.57	462.96
Cost C		19457.86		19131.60
Output				
Main produce(qtls)	28.13	21373.4	26.44	20651.98
By-produce (qtls)	5.67	141.52	5.91	147.38
Total value		21514.92		20799.36
Cost C net of by-produce		19316.35		18984.22
Per quintle cost		686.60		718.09

Per hectare Cost of Cultivation of Gram crops on sample farms

Cost items	Gram			
	Biofertilizer use		Biofertilizer non-use	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	6.72	336.34	6.68	334.09
Female	20.18	807.22	21.15	846.36
Bullok power (pairdays)	7.37	1105.67	6	900.00
Machine Power(hrs)	15.98	1917.53	16.09	1930.91
Seed (kg)	54.74	1642.27	63.55	1906.36
Manure (qtls)	34.02	1701.03	24.82	1240.91
Biofertilizer (gm)	525.77	183.61	0	0
Chemical Fertilizer (Kg)				
N	36.24		33.34	
P	37.94		38.48	
K	10.62		11.84	
Value		1225.98		1224.18
Irrigation charges		1369.59		1262.73
Pl. prtction charges		234.54		66.55
Incidetial charges& Repairs		590.31		553.18
Working Capital (1 to 9)		11114.07		10265.27
Interest on working capital		777.99		718.57
Depreciation on farm impl.		842.68		789.73
Land revenue		36.6		34.73
Cost A		12771.34		11808.30
Rental value of land		5945.96		5326.56
Interest on fixed capital		1546.29		1354.82
Cost B		20263.59		18489.68
Family labour days				
Male	6.88	344.07	7.02	351.14
Female	9.91	396.39	9.14	365.91
Cost C		21004.05		19206.72
Output				
Main produce(qtls)	18.97	35803.09	16.91	32085.45
By-produce (qtls)	9.23	92.27	8.23	82.27
Total value		35895.36		32167.73
Cost C net of by-produce		20911.78		19124.45
Per quintle cost		1102.41		1131.01

Per hectare Cost of Cultivation of Tomato crops on sample farms

Cost items	Tomato			
	Biofertilizer user		Biofertilizer non-user	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	8.43	421.87	8.16	183.33
Female	74.68	2987.50	77.58	1386.67
Bullok power (pairdays)	2.5	375.00	7.67	450.00
Machine Power(hrs)	8.12	975.00	16	800.00
Seed (kg)	0.5	500.00	0.5	500.00
Manure (qtls)	13.75	687.50	30	700.00
Biofertilizer (gm)	312.5	642.50		
Chemical Fertilizer (Kg)				
N	61.56		95.83	
P	32.81		81.33	
K	5.94			
Value		1537.5		2584.67
Irrigation charges		772.5		679.33
Pl. prtction charges		637.5		593.33
Incidetial charges& Repairs		277.5		216.67
Working Capital (1 to 9)		9814.37		5224
Interest on working capital		687.01		365.68
Depreciation on farm impl.		135		162.67
Land revenue		28.75		29.33
Cost A		10665.13		5781.68
Rental value of land		15960.83		14448.44
Interest on fixed capital		442.09		2012
Cost B		27068.05		22242.12
Family labour days				
Male	9.06	453.13	10.66	250
Female	10.62	425.00	9.66	386.67
Cost C		27946.17		23802.12
Output				
Main produce(qtls)	222.5	93437.5	220	79900
By-produce (qtls)				
Total value		93437.5		79900
Cost C net of by-produce		27946.17		23802.12
Per quintle cost		125.6		108.19

Per hectare Cost of Cultivation of Chilli crops on sample farms

Cost items	Chilli			
	Biofertilizer user		Biofertilizer non-user	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	7.91	395.83	6.42	321.43
Female	109.79	4391.67	98.63	3945.24
Bullok power (pairdays)	7.5	1125.00	7.14	1071.43
Machine Power(hrs)	15	1800.00	14.05	1685.71
Seed (kg)	0.25	325.00	0.25	324.29
Manure (qtls)	24.17	1208.33	21.9	1095.24
Biofertilizer (gm)	250	800.00		
Chemical Fertilizer (Kg)				
N	77.92		94.4	
P	97.08		65.83	
K	45		46.79	
Value		2910		2701.9
Irrigation charges		681.67		631.9
Pl. prtction charges		462.5		594.76
Incidetial charges& Repairs		355.83		349.52
Working Capital (1 to 9)		14455.83		12681.43
Interest on working capital		1011.91		887.7
Depreciation on farm impl.		448.33		502.86
Land revenue		39.17		39.52
Cost A		15955.24		14111.51
Rental value of land		6141.39		5279.92
Interest on fixed capital		2748.33		2529.05
Cost B		24844.96		21920.47
Family labour days				
Male	6.04	302.08	5.95	297.62
Female	27.7	1108.33	20.47	819.05
Cost C		26255.38		23037.14
Output				
Main produce(qtls)	61.67	37083.3	53.33	31916.7
By-produce (qtls)				
Total value		37083.33		31916.67
Cost C net of by-produce		26255.38		23037.14
Per quintle cost		425.76		431.94

Per hectare Cost of Cultivation of Brinjal crops on sample farms

Cost items	Brinjal			
	Biofertilizer user		Biofertilizer non-user	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	10.66	533.33	9.87	493.75
Female	107.58	4303.33	98.37	3935.00
Bullok power (pairdays)	9.17	1375.00	6	900.00
Machine Power(hrs)	14.17	1700.00	14.5	1740.00
Seed (kg)	0.5	225.00	0.5	224.75
Manure (qtls)	24.33	1216.67	24.5	1225.00
Biofertilizer (gm)	333.33	494.00		
Chemical Fertilizer (Kg)				
N	62.83		63.94	
P	73.67		78.06	
K	21.33		10.06	
Value		2342.33		2176.5
Irrigation charges		480		533.5
Pl. prtction charges		823.33		758
Incidetial charges& Repairs		236		231
Working Capital (1 to 9)		13729		12217.5
Interest on working capital		961.03		855.23
Depreciation on farm impl.		267.67		315.5
Land revenue		15.67		21
Cost A		14973.36		13409.23
Rental value of land		19623.33		16845.67
Interest on fixed capital		1770.67		1134
Cost B		36367.25		31388.89
Family labour days				
Male	8.83	441.67	8.81	440.63
Female	19.41	776.67	17.18	687.50
Cost C		37585.59		32517.02
Output				
Main produce(qtls)	255	117833	253.5	101200
By-produce (qtls)				
Total value		117833.3		101200
Cost C net of by-produce		37585.59		32517.02
Per quintle cost		147.39		128.27

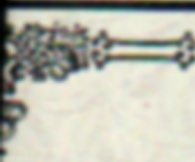
Per hectare Cost of Cultivation of Sugarcane crops on sample farms

Cost items	Sugarcane			
	Biofertilizer user		Biofertilizer non-user	
	Qty	Value	Qty	Value
Hired human labour (days)				
Male	60.2	3010.23	57.42	2871.19
Female	54.74	2192.32	53.2	2128.14
Bullok power (pairdays)	61.52	9228.30	8.35	1252.69
Machine Power(hrs)	26.12	3133.98	40.18	4821.51
Seed (kg)	6784.64	7733.65	6501.97	7153.66
Manure (qtls)	58.22	2926.05	64.44	3222.22
Biofertilizer (gm)	5091.1	656.13		
Chemical Fertilizer (Kg)				
N	166.28		228.35	
P	81.14		107.63	
K	38		104.01	
Value		3878.21		5203.91
Irrigation charges		4909.5		3958.92
Pl. prtction charges		211.04		202.11
Incidetial charges& Repairs		241.73		171.4
Working Capital (1 to 9)		38120.12		30985.74
Interest on working capital		5336.82		4338
Depreciation on farm impl.		963.74		936.38
Land revenue		186.32		145.81
Cost A		44606.99		36405.93
Rental value of land		24665.42		16754.77
Interest on fixed capital		1415.9		1097.89
Cost B		70688.31		54258.59
Family labour days				
Male	90.18	4509.42	69.85	3492.83
Female	11.08	443.37	11	444.27
Cost C		75641.1		58195.69
Output				
Main produce(qtls)	1272.6	94576.6	969.18	71752.7
By-produce (qtls)	120.76	4830.3	96.42	3856.63
Total value		99406.93		75609.32
Cost C net of by-produce		70810.81		54339.06
Per quintle cost		55.64		56.06

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VITA



9. VITA

YASHWANT CHANDRABHAN SALE

A candidate for the degree

of

Master of Science (Agriculture)

2004

Thesis Title : "Impact of Biofertilizer Use on Crop Productivity in Ahmednagar District".

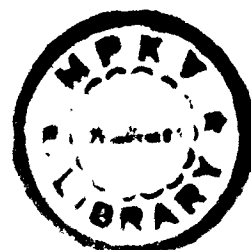
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